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A Lead User Approach to Universal Design – Involving Older Adults in the Design Process

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Abstract. The concept of Universal Design has received increasing appreciation over the past two decades. Yet, there are very few existing designs that cater to the needs of extraordinary users who experience some form of physical challenge. Previous work has shown promising results on involving users with physical challenges as lead users - users who have the potential to identify needs that could be latent among the general population. It has also been shown that older adults can act as such lead users. They can help design universal product ideas that satisfy both older adults and the general population. In this paper we build on this and examine if involving older adults in the design phase can result in universal products, products preferred by both older adults and the general population over a current option. Eighty-nine older adult participants and thirty-four general population participants took part in the study. Products were redesigned and prototyped based on the needs of older adults and tested among both populations. Results show that, although older adults and the general population did share certain needs and demands, the majority of older adults had needs and demands that were different from those of the general population. However, even though the needs differed between the populations, on average 89% of the general population participants preferred products designed based on design needs expressed by older adults over the current option. This provides further evidence supporting the use of older adults in designing products for all.

Keywords. universal designs, lead users, older adults, extraordinary users, latent needs

1. Introduction:

Ron Mace defined Universal Design as "the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" [1]. To be precise, universal designs are designs that enable the users and not disable them irrespective of their age or ability. Accessible building design was the initial step towards designing an inclusive environment for older adults and differently abled people [2]. Later, during early 1990s, focus shifted to a broader level

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where designs for older adults started to get addressed as designs for the future us [3] and in 1997, the seven principles of Universal Design were compiled.

A good design accommodates a user's existing abilities rather than highlighting what they lack, designs that fail to fulfil this requirement leave the user feel disabled. Designers in general being able bodied individuals, who adapt to design changes at a faster rate, have different needs than an older adult or a user with physical challenges [4]. Moreover, needs being a source for innovation, design innovations tend to get limited to the needs experienced or realized by the designers[5, 6]. In order to avoid such instances, Persad, Langdon and Clarkson [7] provided an analytical evaluation to bring an awareness on the number of users who are most likely to be excluded from using a product due to its design limitations. Simulation tools that enable designers experience needs of people with limited abilities were also developed [8].

Needs experienced by extraordinary users (E.g. users with physical challenges), in many cases, are at some point experienced by normal users as well [9-11]. For example, needs of a user with hearing impairment coincides with that of a normal user trying to hear under a noisy environment [12]. Further, commercially available designs like OXO Good Grips™ houseware, Ford Focus™ cars, and Fiskars Softouch® scissors [13] are other examples that demonstrate the success of such designs. Hence, including older adults or users with physical challenges during design ideation could provide new ideas that not only satisfy their needs but also the needs of a larger population.

Extraordinary users' ability to perceive needs that satisfy the design needs of normal users could be related to the 'lead user' theory. 'Lead users' (term coined by Eric Von Hippel in 1986) are ones who experience a need much before the rest of the population realizes it [14]. People who experience extreme situations such as loss of ability have needs that are not realized by the average population hence, could qualify as lead users [15-18]. Similarly, older adults who experience loss of dexterity, strength and other abilities with age [10, 19] also experience needs that are not voiced by younger adults in general[20]. This indeed let to research that targeted the design needs of older adults, with an intent to help them function independently[21].

Involving potential users in design process has become a key to framing design requirements, but involving older adults in the process has not been widely used. Joyce et al. [22] proposed that ageism is a significant contributing factor leading to poorly designed artifacts being produced for older adults due to negligence of their experiences, needs and desires. There are works that share experience and contribution of older adults in technology and design. The formalized deliverables of work often serve to stifle the contribution of older participant when they are engaged in the design process [23]. Michael & Ronald [24] conducted studies involving older people in customizing mobile phones and notes that the participants were very good at critiquing designs, mediocre at screen design, and very poor in imagining next-generation technology. Stephen et al. [23] using OASIS approach of participatory design with older adults and shared experiences of conducting each step in the approach which are lessons learned for future studies. Their work also mentions challenges in engaging with older people which can be watch areas to effectively conduct studies. However, uncovering older participants' perceptions led to researches fundamentally rethink their attitudes towards design project [23].

This paper will focus on need finding and design of products that not only satisfy the needs of older adults but also fulfil the requirements of the general population. We will analyze the feasibility of designing products for the general population by using older adults as 'lead users and also on the extent to which the general population accepts

those products. Previous work showed how older adults acted as effective sources for innovative product ideas, i.e. as lead users for products for the general population as well [20]. This paper will analyze the same with a larger sample size and also include design suggestions from older adults in creating universally designed prototypes. *The study will aim to answer the following two research questions:*

1) *Do older adults have more needs than the general population?*
2) *Will the general population accept products designed based on the needs of older adults?*

2. Research Methodology

Figure 1 summarizes the flow of research approach followed during this research. From this point, the term 'older adults' will refer to participants above 65 years and the term 'general population' will refer to participants between 21 to 55 years. Subjects between 55 to 65 years were excluded from this research to allow for a clearer distinction between older adults and the general population.

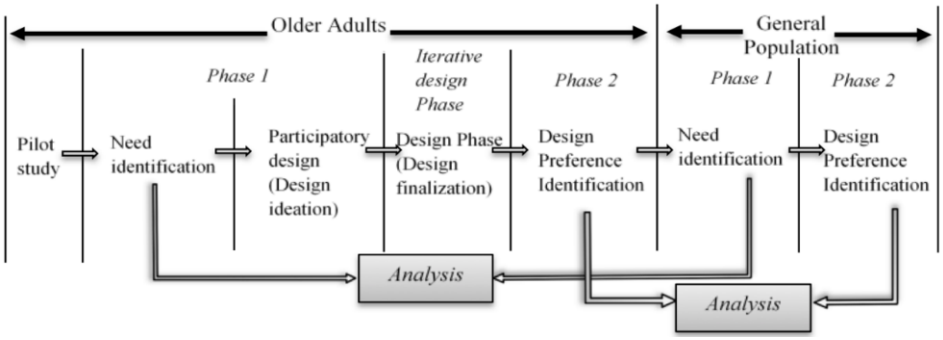


Figure 1. Research Approach

Our research approach involved two main phases (Phase 1 and Phase 2) and a Design phase. Phase 1 targeted need identification and participatory design while Phase 2 aimed to analyze the design preference of older adults and the general population. The Design phase was an iterative phase for Phase 2. During the iterative phase, products redesigned using comments from older adults and design suggestions were taken back to the older adults for their feedback. This was to ensure if the implemented modifications fulfil expectations of older adults.

For all 3 phases, older adults at various Senior activity centres in Singapore were approached upon receiving approval from the centre manager. They were initially briefed about the project and the research team made sure that their participation was completely voluntary. Apart from the Senior activity centres, older adults were also approached at different locations such as, outside shopping malls and other public spaces. Most participants from the general population group were approached at public spaces within SUTD (Singapore University of Technology and Design) such as, canteens, labs and walk ways, and some were recruited at other public spaces such as malls and food courts. Interaction with participants started with a briefing on the Participant Information Sheet and the study commenced only after the participants gave their consent via consent

forms. Subsequent sections will give a detailed description of the research approach followed for each phase.

2.1. Phase 1: Need identification and design ideation

Older adult participants were given a questionnaire that had a list of tasks and were asked to choose the tasks they disliked the most based on the products used. The questionnaire listed simple day to day tasks like opening a sealed water bottle, making their bed, using a manual can opener etc. We restrained from including suggestions from the general population since our emphasis was on seeing if older adults can be lead users and whether their design suggestions could be accepted by the general population. The general population's involvement in Phase 1 and 2 happened only after completing Phase 2 with older adults, this was to avoid any kind of influence by participants from the general population in redesigning the products. Phase 1 had 68 participants in total, having equal number of participants from each population (34 older adult participants and 34 general population participants).

Design needs and suggestions from older adults were obtained via focus groups as well as individual interactions. The number of participants per table ranged from four to six and each table had two facilitators. Study procedure for participants from the general population and older adults outside the senior activity centres had a similar approach but the participant number varied from one to five. Questionnaires for older adults were marked by the facilitators simultaneously as older adults made their choice. The older adults were asked to suggest alternative designs for those products they disliked the most. They were also encouraged to sketch their designs.

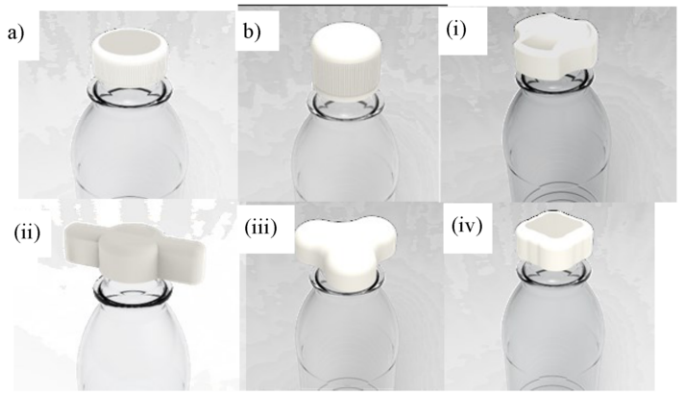
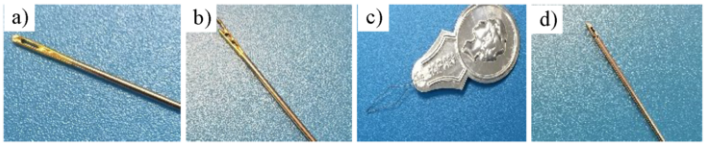
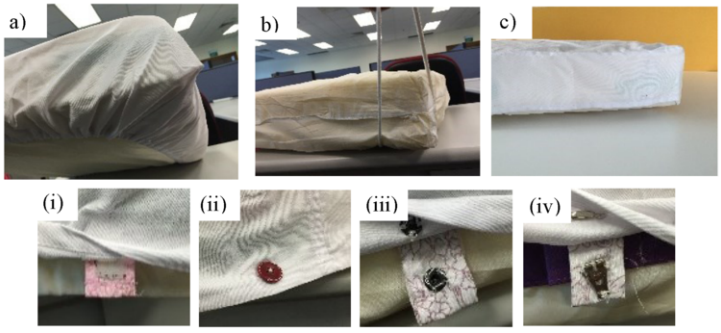
2.2. Iterative Design approach

Design solutions to pursue further were decided based on the feasibility of needs and suggestions shared by older adults during the ideation sessions. For this, four tasks were shortlisted and products corresponding to those tasks were redesigned. Products were shortlisted based on two main factors 1) Feasibility of design suggestions provided by the participants 2) Difficulty rank obtained by each task. Usually, most of the participants expressed difficulty with a particular aspect of a task or product. For example, lifting a mattress was the most difficult task or the task they disliked the most while making their bed. Consequently, the redesigned products focused on easing that task. Shortlisted set of products were water bottle cap, sewing needle, mattress and soda can.

Three options were designed for each task. One design was similar to the one existing in market, another was a redesign based on the needs of older adults and the third was a decoy. The decoy was included in order to avoid the new designs being obvious to the participants. The decoy was different from the current solution but it did not alleviate any difficulty and was functionally equal to the existing product. All three versions were created with similar methods to avoid any biases.

In case of the soda can, we noticed the decoy unintentionally solved some of the problem faced by older adults and ended up thus not being a genuine decoy but an improved design. Since the participants had already started to take part in the study, the research group decided to continue the study without providing a decoy option.

Table 1. Prototypes used for Phase 2

Water Bottle cap	 a) Existing water bottle cap b) Decoy water bottle cap (i, ii, iii, iv) Redesigned water bottle caps: (i) 3 fold (ii) Double extension (iii) Triple extension (iv) Square shaped
Feedback and design details by older adults	**Feedback:** Provide better grip **Design change:** Four different design suggestions that provide better grip were proposed
Sewing Needle	 a) Existing needle b) Simplified calyx eye needle c) With assistive device (Decoy) d) Spiral eye needle
Feedback and design details by older adults	**Feedback:** Calyx eye needle looked simple but it was still difficult to spot its head while threading **Design change:** Redesigned simplified calyx eye needle and existing spiral eye needle designs enable the users to thread with minimal visual guidance.
Mattress	 a) Existing mattress design b) Decoy design c) Redesigned mattress design with: (i) Hook and loop fasteners (ii) Buttons (iii) Snap buttons (iv) Hook and bar fasteners
Feedback and design details by older adults	**Feedback:** 1. Different materials that could be used to fasten the mattress 2. Lose ends make it look messier **Design change:** Redesigned mattress had 4 subdivisions (i, ii, iii, iv) due to different types of materials that could be used for the same design and the mattress cover was designed to fit the mattress.

Soda cans	 a) Existing soda cans b) Soda can with a lifted pull tab c) soda can with a deeper dent below the pull tab
Feedback and design details by older adults	**Feedback:** A deeper dent under the pull tab would make more space for the finger **Design change:** A deeper dent

This phase helped refine design modifications to fulfil the expectations of older adults. Older adults in this phase might or might not have been the same participants who took part in Phase 1. 25 older adults took part in this phase. Participants from the general population group were not involved during this phase.

Based on comments and feedback from the iterative Phase, first set of prototypes were again redesigned. Only the aesthetic quality of the prototype was changed for the existing and decoy designs provided during the iterative phase. Prototypes that were provided during the Iterative Phase made it easier for older adults to provide precise feedback on the products hence, resulting in more number of alternate design suggestions. Table 1 lists the prototypes used for Phase 2 along with the feedback that they are built upon and their corresponding design change.

2.3. Phase 2: Design preference identification phase

60 participants (30 older adults and 30 general population participants) were involved in Phase 2. First 30 general population participants from Phase 1 were involved in Phase 2 as well once they completed Phase 1. The final set of prototypes modified based on the comments from the iterative Phase were provided to the participants. Due to the increased number of ideas that poured in during the iterative Phase, there were about two to five design alternatives for each product. These final prototypes were given to each participant and they were asked to choose the one they would prefer to use. Each participant was directed to record their choice on a questionnaire that was given to them. Similar to Phase 1, facilitators marked the questionnaires for older adults simultaneously as they made their choice over given prototypes.

The questionnaire listed the prototypes along with corresponding pictures to avoid any misinterpretation. The number of design alternatives for each product varied depending on the number of feasible design needs and suggestions provided by older adults. Feedback collected was used to analyze if the design preference of older adults and the general population correlated with each other.

3. Results

3.1. Phase 1

Figure 2 displays the outcome of survey conducted during Phase 1, it displays the percentage of participants from each group (older adults and general population) who disliked the tasks listed in the questionnaire. The results were different from what was

anticipated. The average number of difficulties experienced by participants from the general population was the same as that of average number of difficulties (and thereby needs) experienced by older adults.

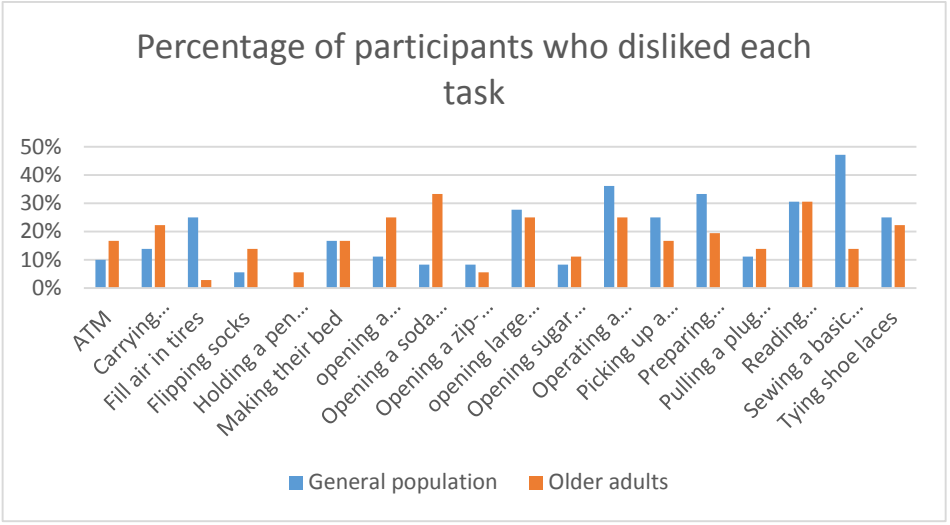


Figure 2. Percentage of participants who found the listed tasks to be challenging

Table 2. Percentage of participants who preferred each product

	Outcome			**Restructured Outcome**		
Products	**Designs**	**General population**	**Older adults**	**Designs**	**General population**	**Older adults**
Needle	Thread Through Hole	0%	4%	Thread Through Hole	0%	4%
	Decoy (Assistive Device)	17%	11%	Decoy (Assistive Device)	17%	11%
	Extended Self-Threading	33%	57%	**Redesigned Needles**	83%	93%
	Spiral Eye Needle	50%	36%			
Soda Can	Straight	0%	3%	Straight	0%	3%
	Lifted	27%	53%	**Redesigned Soda Cans**	100%	97%
	With Dent(Deeper)	77%	43%			
Water Bottle Cap	Round	10%	10%	Round	10%	10%
	Decoy	3%	0%	Decoy	3%	0%
	3 Fold	40%	23%	**Redesigned Water Bottle Caps**	87%	93%
	Double Extension	10%	33%			
	Triple Extension	17%	27%			
	Square	23%	10%			
Mattresses	Normal	13%	18%	Normal	13%	18%
	Decoy	20%	14%	Decoy	20%	14%
	Velcro	43%	25%	**Redesigned Mattresses**	87%	75%
	Button	23%	43%			
	Snap button	20%	4%			
	Hook	3%	4%			

3.2. Phase 2

Phase 2 intended to analyze the extent to which the general population accepts design suggestions from older adults. Table 2 lists the percentage of participants from each group who preferred each design along with a restructured outcome that combines the preference given for all redesigned products. The choice by both populations were distributed across all options and there were participants who preferred more than one design. Though the design with maximum preference differed between each group, it can be observed from the restructured outcome that, on average 89% of the general population and 90% of older adults would prefer the redesigned products over existing ones.

4. Discussion

It was evident from the interactions with older adults that a wide range of existing day to day products do not comply with the Universal Design principles and this eventually led to older adults ignoring tasks due to the design complexity of the products. For instance, many older adults had started to wear slippers to avoid shoes that demand bending to wear a sock or to tie the laces. Hence, analyzing such needs will not only let designers explore designs from a different perspective but also result in products that satisfy needs that are not expressed by the general population. Two research questions were raised at the beginning of the paper, answers for those research questions are as follows:

Research question 1: Do older adults have more needs than the general population?

Results from Phase 1 show that there is no significant difference in between the number of needs experienced by older adults and the general population. The results show that both older adults and the general population users, on average, experience similar number of needs. Though both the populations expressed similar number of needs, majority of the needs listed were different for each population. A product designed exclusively based on the needs of the general population will tend to eliminate the needs felt by an older adult. To conclude, older adults might not have more needs but have different needs than the general population.

Research question 2: Will the general population accept products designed based on the needs of older adults?

Each and every redesigned product was designed based on the needs and suggestions shared by older adults. Results obtained during Phase 2 show that, on average, 89% of the general population participants preferred those redesigned products. Especially, very few participants from the general population group listed opening soda cans as a difficult task during Phase 1 but, each and every participant from the same population preferred the redesigned soda cans during Phase 2. This shows that needs experienced by older adults might be capable of indicating the latent needs of the general population and that such approach will trigger innovative ideas that might be accepted by the general population as well. Thereby making them universally designed products. To further support this, the Simplified calyx eye needle - an outcome of this study, was shortlisted for RedDot design awards 2015. Such recognition implies the acceptance of products designed using the needs of older adults amongst the general population as well.

5. Limitations

While our results show clear support towards using the needs of older adults for designing products for all, no study is without limitations. During Phase 1, participants from the general population were insisted to reason their dislike towards the tasks they had listed. But, at certain instances the participants did not mention those reasons on their questionnaires. For example, many participants felt sewing and preparing food was a difficult task due to their lack of knowledge about the task but that was not mentioned in their questionnaires. This made it difficult to separate participants who picked a task due to design complexities from participants who picked it due to lack of knowledge. This could have affected the participant percentage for those tasks. Common to all focus group studies, participants from the senior activity centres were observed to be influenced by other people around them. This kind of influence could have created a bias amongst the needs shared by the participants. Another factor to be taken into consideration is that, almost 50% of participants from the general population group were students who had a design background. This could have had an effect on the needs and suggestions shared by the general population.

6. Conclusion and Future work

This work involved both older adults and the general population in a design study, identified their design needs and found that older adults had needs different from those of the general population. An approach was proposed to involve needs of older adults in designing products for the general population and redesigned products were also tested among the general population. This proved that older adults could be of great advantage during needs gathering and that products designed based on their needs qualify for universally designed products since they benefit a wider population.

In future, conducting more iterative phases during the study will help refine ideas and design products that are more precise. Considering aesthetic quality of the products could also make them more desirable and accepted by a wider group of users. Further studies should also focus on needs that differ between different age groups of older adults. This would help understand different needs experienced by older adults and also expand the number of potential design suggestions.

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