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Participation is Blind: Involving Low Vision Lead Users in Product Development

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Abstract

Involving end-users during the development of assistive devices may reduce low satisfaction rates. Yet, involving just any users does not guarantee product success. We propose the lead user method for user involvement during development of systems aimed at improving accessibility. We introduce a case study where we used the lead user method during the development of an accessibility device aimed at improving mobility among low vision persons. Additionally, we review the theoretical background of this approach, introduce our case study and reflect on the lessons learned. The lead user method used in this context offers benefits such as the ability to quickly iteratively design solutions, while offering designers the chance to better understand the context of use. Potential pitfalls of this approach are the selection of the correct lead user, possible increased costs and, design proposals that are not useable to the rest of the target group. Finally, we introduce new research themes related to the involvement of lead users in the development of accessibility products.

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Keywords: lead user; user innovation; co-creation; user involvement

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1. Introduction

High rates of abandonment are not unusual for assistive devices, reaching up to 29% [1]. Not enough end customer involvement may be one reason why devices are abandoned at such high rates [2], but reasons may also include lack of training, or low rates of user acceptance to a proposed solution [3]. This presents designers of assistive systems with the task of better understanding end users. A user centered design approach may offer ways of mitigating some of these issues. This way of designing, also described as ISO 9241-210 [4] is based on the active involvement of users to improve the understanding of user and task requirements, and iteratively designing and evaluating prototypes [5].

User involvement as a development strategy has been advocated since the late 1970's [6], but at the same time, designers should take care not to just involve any users, since user involvement may not always solve issues related to product use and could even result in worse outcomes [7]. A reason for this can be the involvement of users lacking real world experience or knowledge about a particular proposed solution [8].

One specific way of involving users in design and development is the lead user method [8]. Based on the idea that lead users have increased needs and are motivated to provide solutions to have these needs solved, the method emphasizes involvement of smaller, but specific groups of end users, as opposed to just any persons from within the group of potential end users. This approach has been successfully used in various domains, including assistive devices [9]. For example, Tangsri et al. describes the involvement of a lead user in the development of a group learning system aimed at visually impaired students [10].

We used the lead user method in the development of an assistive device for increased mobility aimed at visually impaired persons. In this paper, we specifically present how we applied this approach, focusing on the tools and techniques we used. Additionally, we reflect on the benefits and issues related to this specific method, relating these insights to systems for increased accessibility.

The rest of the paper is structured as follows. In section two, we will present a theoretical background to user involvement and the lead user method, while section three gives a brief system description. Section four introduces our methodological approach, with section five reflecting on the challenges we experienced. Section six concludes the paper.

2. Theoretical Background

2.1. User Involvement

Especially in the design of systems or devices aimed at increased accessibility, there is room for improving the user's experience, given high rates of abandonment [1]. Issues such as user non acceptance, solution inappropriateness, or lack of training are cited as important factors why users chose to do away with certain assistive devices [3]. In turn, this introduces the need to better understand end users, their needs and the context of use.

The notion of involving end-users in product development, either through user research, or product evaluation, has gained a foothold as method for improving products and has been seen as a way to increase system success [6]. A variety of methods exist to involve users, including interviews, observations or generative workshops [11]. Especially in the case of generative workshops, the role of the end-user shifts from subject of research to partner in development [12]. In the development of assistive devices, user involvement is also common, including before product development [13] and as a way to evaluate results [14], [15]. Ultimately, how satisfied users are with the system is an important factor to evaluate and determine system success [16].

Yet merely involving users will not automatically result in usable products with high customer satisfaction. While an emphasis exists on early and final phase involvement - when the requirements of the system are being developed and finally tested - involvement should extend beyond that to other phases of development [17]. Reviewing 87 cases of user involvement in system development, Bano and Zowghi [7] stress that user involvement is not always easy, or may not always lead to good results, especially when involving the wrong types of users. Additionally, involvement also requires time and effort and it should be clear what the degree of involvement will be [7], with the combination of user involvement, system types, task complexity and stage of development also playing an important role in system success. Relevant is the idea that the appropriate type of user should be involved at different stages of development, expanding beyond involving just any users from within the cohort of end users.

2.2. The Lead User Method

The notion of having the right types of users for user involvement aligns with Von Hippel's [8] lead user method. Initially presented as a method to develop new industrial products, it has since been used and evaluated in very diverse domains [18], [19]. Central to the method is finding particular persons that are experiencing needs not yet felt by the general market. These persons, due to their increased needs, are also more motivated to find solutions that will satisfy them, if they have not already done so through modifying existing products [18]. Given these characteristics, they are often a limited group of persons with specialized skills or experiences [8]. They may thus be technically skilled, highly dissatisfied with current products or experts in a particular domain [20]. A succinct description would be that they are "living in the future", experiencing needs that most other people are yet to experience.

To implement the lead user method, Von Hippel has suggested a four-step approach. First, lead user indicators are specified, where the characteristics of the intended lead user(s) are defined. This may be the need for specialized technology, or being an expert user of a product in extreme conditions. Second, a lead user group is identified. Using the indicators specified earlier, potential markets or groups could be searched for persons adhering to the lead user indicators. Third, once found, concepts are generated through meetings, brainstorms or other generative methods. Alternatively, data can be gathered about solutions that have already been implemented by the lead users. As a fourth and final step in the method, concepts are evaluated and tested with non lead users [8].

While many variations exist to find lead users, they fall within two broad categories. First, users could be screened, either through quantitative surveys, or by looking for lead users in other forums such as online message boards. By predetermining certain attributes (the first step in the lead user method), potential users can be filtered out to identify those that adhere to lead user characteristics such as high expertise [8]. A second variation is "pyramiding" [21], also known as "networking" [22]. Based on the idea that enthusiasts about a topic usually know people more expert than themselves about the same topic, pyramiding allows finding lead users at the forefront of a need or trend.

The benefit of the lead user method lies in the notion that products at the leading edge of technological developments require thinking of needs and opportunities that are not yet clearly felt by many in the market. As such, involving just any user may prove problematic, since they are not always capable of clearly defining their needs, as these needs are not yet felt. In the development of technologies for accessibility enhancement, this may be an important approach. Products are typically novel and may solve needs that are not yet fully understood or felt by the rest of the market.

2.3. Disabled Persons as Lead Users

Franke and Shah [18] describes a relevant case study of how the lead user method results in innovation. Through studying sport communities, the authors detail how a community of cyclists with amputated arms redesigned their bicycle braking systems to be more usable. Additionally, Leahy [9] discusses targeted consumer involvement in the development of an assistive device that helps deaf persons to hear important environmental sounds, emphasizing the importance of having the right types of users throughout various steps of the product development.

These examples accompany several others that emphasize the innovativeness of disabled persons as lead users [23]. Framed as lead users due to their adherence to the two lead user characteristics introduced earlier - being at the leading edge of a market trend and expecting high benefits of obtaining a solution - they are motivated to think of solutions, while also offering alternative perspectives on design problems due to their radically different experiences.

We are aware of the potential criticism associated with terms such as disability. While alternatives such as "differently abled" have been suggested [24], we agree with Jones [25] that the term "disabled" acknowledges that disability can be a disadvantage which can be mitigated by changing the person's environment. Additionally, the term is recognizable and used widely, including by the WHO [26] and other supra-national organizations such as the United Nations [27].

The idea of disabled persons as lead user has also been introduced earlier by Hannukainen & Hölttä-Otto [28]. The authors have illustrated how persons with disabilities contribute to product innovation. Using ethnographic studies of blind and deaf persons and their use of mobile phones, they argue that the needs of extraordinary users in their study can be related well to those of non-disabled users. Additionally, Conradie et al. [23] reviewed 18 cases where persons with disabilities collaborated in various ways to create new products or services, for both assistive and mass market products. Examples included the design of toothpaste packaging [29], but also development of specialized assistive devices such as prosthetic limbs [30].

While these cases argue for user involvement, there is still a lack of literature focusing on exactly how to achieve lead user involvement, how lead users can be detected, and what the relevance of this method may be for assistive device design specifically.

3. System Description

Due to the lack of visual information, systems that provide blind persons with information about their surroundings to support mobility make use of either auditory or tactile substitution[31]. Such systems rely on input from many types of sensors, such as GPS [32], cameras [33], external RFID tags [34], or online map sources [35].

Our focus in this paper is a system intended for vision impaired persons. The aim of the system is to enable blind persons to better navigate in indoor environments such as train stations. Additionally, the radius of obstacle detection will increase from 1.5m - the traditional distance enabled by the white cane – to 7m. The system cost should be below that of a guide dog. It should also be portable. It consists of a 3D, time-of-flight camera, combined with a wearable tactile display. Images captured by the camera are thus translated to tactile feedback patterns by the belt, which subsequently allows the user to be able to circumvent existing obstacles such as stairs, or dustbins.

4. Methodological Approach

4.1. Finding Lead Users

How did we apply the lead user method in our research? Given that the method's most important focus is finding appropriate participants through screening or pyramiding, an important first consideration is finding the right participants. Following this, generative sessions are used to arrive at new product ideas, while concepts are subsequently re-evaluated with non lead users [36].

When focusing on disabled lead users, the potential group of participants may be much smaller. It may not always be possible to locate persons that have already developed solutions specifically to solve issues related to indoor mobility. To still be able to select appropriate lead users, alternative strategies to locate them must be used. As other authors have pointed out, this could be barriers to participation such as having to travel far to participate in group discussions[30], increased technical skills [37], or involvement in the local community of peers [10]. Chosen lead user characteristics may also be a combination of these factors.

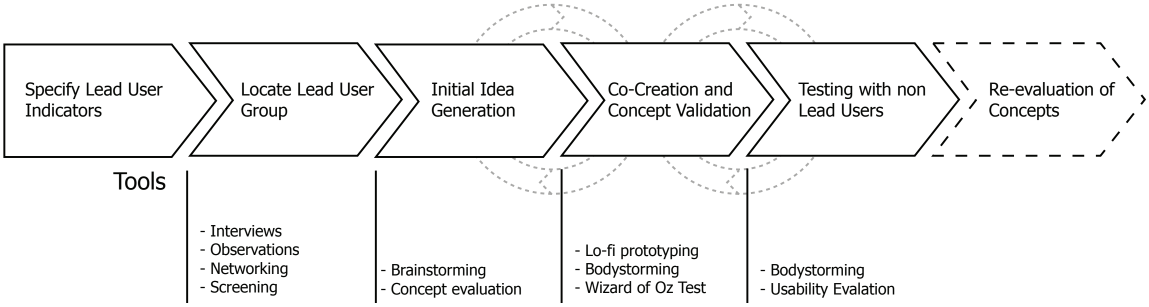

Fig. 1 User Involvement during the lead user method and associated tools

As initial stage, we conducted qualitative interviews with six (four females and two males) blind persons by phone, followed by two focus group discussions. Group 1 contained nine participants, while group 2 contained twelve. Interviews and focus group discussions served a dual purpose. First, the experiences and knowledge of blind persons was revealed to the researchers. This made it possible to sketch broad user needs within the target group and specifying varying degrees of mobility needs and assistive device demands. Secondly, the interviews allow for pyramiding [21]. By asking participants if they could recommend other persons that could provide more information, more people could be screened. By doing so, lead users could be located. Specifically, our lead user characteristics were defined as: 1) having high mobility needs, and 2) being fluent in talking about technological trends and finally 3) critical reflection on current deficiencies of assistive devices. We followed up these interviews with studies at people's homes, where adaptations to the home environment were discussed. In total, four interviews were conducted at home. During the interviews, we first tried to understand the general problems associated with mobility from the perspective of our users. Following this, we reviewed the currently used devices and tools that some of the participants already have. Finally, we suggested some new system improvements.

This interview structure allowed us first understands the degree of needs. This is important, since some persons may have many needs already met. For example, one participant has access to a chaperone when going for walk or visiting a hospital. Reviewing current systems used helped identify persons with a lot of knowledge about available systems, while simultaneously indicating to us how dissatisfied they were with current products. Lastly, the process of suggesting new solutions makes it possible to identify critical users.

Through this process we identified a single lead user, Lucas (name anonymised), within the cohort of participants. Lucas adhered to our lead user criteria: besides having high mobility needs, he was able not only to critically reflect on our proposed solutions, but also offering alternative ideas. Additionally, he has a good understanding of the possibilities of current technologies, and had a background in informatics.

4.2. User Involvement

Determining lead user characteristics and finding a lead user concludes the first two steps of the lead user method. Following this, new concepts are generated and tested. This requires methods of user involvement. We applied a mixed method approach using a variety of generative and evaluation methods. The initial process is notably low-fidelity, which allows designing quickly and iteratively. Because our participants cannot rely on visuals to communicate ideas, we had to depend on physical tools instead. For example, we used clay to develop prototypes that allow reviewing physical properties such as size and shape of, for example, the 3D camera and its placement. Materials such as paper, Velcro and strings also allow us to quickly make dummy versions of wearable systems. In turn, having a physical dummy prototype enables changes to be made during the workshop if needed and to reflect on any improvements.

To validate concepts, we relied on a bodystorming technique [38]. Bodystorming is often applied in the design of ubiquitous systems and relies on certain props, with participants acting out scenarios related to the generated concepts[38]. Specifically, we explored interaction with the system, combining a dummy wearable camera in combination with tangible input prototypes. We can thus rapidly iterate during prototype development. Users and designers can experience a mock-up of the system, focusing specifically on the experiential components, besides only physical properties. These types of evaluations can be related to Wizard of Oz tests, where system functionality is emulated, instead of completely functional [39].

In addition to contributing to ideation and evaluation of co-created ideas, we also invited Lucas to participate in one of our consortium meetings, where he could offer his expertise. This proved helpful, allowing team members quickly review concepts and ask specific questions about mobility. Besides helping to provide first-hand experiences to the whole team, it further extends the lead users.

4.3. Evaluation of Concepts

One criticism leveraged against the lead user method is that the chosen lead user's ideas may not be representative of the cohort of other users [12]. Von Hippel suggests solving these issues by evaluating concepts with non-lead users. We acknowledge these issues and through system evaluation aim to find any issues related to the concept system. Having already developed a network of potential users through the lead user search (Step 2 of the method), we already had access to multiple users, which makes evaluation easier.

During our evaluation with non-lead users (n=5) we emphasized issues such as the user interaction with the system, the wearability of the prototype components and the overarching concepts related to the use of the system. These may include use of different modes, based on the needs of the user, but also more general mobility needs, since these may differ from those of the lead user. For example, a lead user may have high mobility needs and will subsequently be more willing to accept wearing environmental sensors, while for someone with less extreme needs, this willingness will be less.

To evaluate concepts, we once again used bodystorming method [38], combined with more formal evaluation methods such as Knight's [40] tool to assess the comfortability of wearable devices. These evaluations contributed to a better understanding of user needs, especially when compared to the lead user, revealing issues that were previously not yet apparent. Finally, we propose a re-evaluation of concepts, if needed, based on the results of the tests of non-lead users.

5. Discussion

5.1. Benefits of this approach

User participation remains complex and merely involving users are not a cure-all to solve issues related to the system, as mentioned earlier. Like some other high-technology fields, assistive devices can include technologies that are not yet known to the general market. Given this, we chose the lead user method to involve our end-users in the system development. We see some advantages of this approach and they also relate specifically to system design for assistive devices.

First, the search for a lead user is an ideal opportunity to be submerged in a new theme and better understand the context of the end user, while also building a network of participants. Interviews and observations are often used to gather user requirements in early phases of both assistive devices and system development. Screening the end user group to locate lead users thus serves the dual purpose of finding a lead user, but also better understanding of the user group as a whole.

Secondly, once a lead user has been found, it is possible to intensively work towards tangible design results while being able to iterate very fast and efficiently. A mixed, low fidelity prototyping approach makes discussing and evaluating concepts possible, allowing changes to be made as soon as problems with the concept or design are discovered. For example, issues with particular interactions or concepts are quickly revealed and can be adapted.

Third, the lead user method specifically matches well with the issues associated with system design for accessibility. Projects such as those introduced earlier, involving technologies not yet commonly understood by broad user groups (such as RFID technology [34]), are typically implying near future scenarios. By virtue of "living in the future" lead users are specifically relevant in assistive device development.

5.2. Issues associated with this approach

However, some issues are also associated with the method. First, as suggested earlier, the selected lead user may be too extreme. In this case, the types of concepts or the willingness to use a system to have certain problems solved may be too extraordinary. A user that is "living too far in the future" may be willing to subject themselves to more inconvenience than other less extreme users.

This can be partly mitigated by testing concepts with non-lead users, but this may already be too late during the process. However, it can be helpful to consider less extreme users, together with the lead user, while generating concepts, to keep ideas grounded. Another important consideration is the innovation potential of non-lead users without prior technical experience or knowledge. Illustrative of this is a study by Davidson and Jensen [41] where older adults with the least knowledge of smartphones generated the most creative designs. This further emphasizes the importance of also involving ordinary users in this process.

Since the method implies first searching and interviewing existing users, prior to co-creating solutions with a select few, the approach may have higher costs. Given the comparatively niche user groups of assistive devices, locating a lead user may prove a challenge.

More broadly, involving disabled persons in co-design efforts also raises some ethics consideration. For instance, managing expectations is important. To illustrate, Frauenberger et al. specifically mention issues encountered when co-designing with special needs children [42]. The use of proxy users in these cases might also be of value. While it is not recommended in all cases, in certain contexts where participants are unable to communicate, a proxy user might be used. In such case, the lead user may be someone representing the person with disability. This may be the case for persons with severe dementia or Alzheimer [43]. Note that the proxy user - in the form of a family member or caregiver - might also be a lead user due to high needs, and expected high benefits when a solution is found.

Finally, the right types of generative methods may also be needed to achieve success [7]. While interviews may be sufficient to screen for lead users and explore the context of a particular user group, concept generation relies on more interactive approaches. Creative use of tools must be considered.

6. Future work

In this paper, we suggest that use of the lead user method is specifically relevant when developing systems for improved accessibility. This is partly due to relatively high rates of abandonment, but also the need for the involvement of specific users, as opposed to just any persons within the intended group of users and the novel character of many assistive devices.

We detailed our specific implementation of the lead user method, explaining how we selected our lead user, their involvement and validating the results. Our emphasis was on exploring the tools needed within the lead user method. However, while the lead user method has shown its benefit in various domains, more comparative studies would strengthen the argument. For example, how high is the difference in ideation effectiveness between disabled lead users and disabled non-lead users?

In addition to this, we also think that persons with disabilities may offer insights above and beyond the development the development of assistive devices. For example, the needs of persons with disabilities may extend beyond what current commercial products offer, placing them in a position as lead user in relation to other non-disabled persons.

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