NordDesign 2016
August 10 – 12, 2016
Trondheim, Norway

Guidelines for Finding Lead User Like Behavior for Latent Need Discovery

Katja Hölttä-Otto[1], Sujithra Raviselvam[2]

[1]Design Factory, Department of Mechanical Engineering, Aalto University
Katja.Holtta-Otto@aalto.fi
[2] Engineering Product Develop Pillar, Singapore University of Technology and Design
Sujithra@sutd.edu.sg

Abstract

Lead users, users that have a need before the general population and that may even have invented a way to solve the need or problem have been proven excellent sources for innovation. However, traditionally these lead users are the top of their field experts or extreme sportsmen and thus few in numbers and hard to find. In this paper we propose potentially useful dimensions for finding greater numbers of users that exhibit lead user like behavior. Three of these dimensions are experimentally tested. Results show that the tested dimensions of ability, age, and degree of development in deed help in finding people with lead user like ability to express latent needs, needs that are shared with but not originally found in regular users.

Keywords: Innovation, User Centred, Lead User, Need Finding

Introduction and Background

Meeting user needs is a target that companies aim for in order to compete in the market. Many need finding methods have been developed for this purpose. Proper need finding can, however, be expensive. Hauser (Hauser, 2008) describes proper need finding requiring a team of experts 250 person hours. It is likely simpler user interviews are practiced in many, usually resource constraint, companies. There are many avenues for possibly more effective need finding. These include in-depth methods such as observation or large scale methods such as crowdsourcing of ideas. A difficulty in many methods is that a customer is not always able to vocalize what they wish in a new product. The needs not explicitly mentioned by customers are called latent needs. Lead User method (von Hippel, 1986) is a method developed to identify these latent needs. *Lead users face needs before the bulk of the users encounters them* (von Hippel, 1986). Thus they may be a valuable sources for latent customer needs and product ideas already during product development.

In most reported cases lead users have been users or organizations that push the limits of the given application. For example, innovations such as antilock braking systems (ABS) were first developed by the aerospace industry (Von Hippel, Thomke, & Sonnack, 1999). Also extreme

sportsmen have been shown to act as lead users in order to improve their equipment and thus performance (Schreier & Prügl, 2008; Von Hippel, 1986).

Given the potential value of lead users, multiple approaches have been developed in order to easily identify the relevant lead users. Some work focus on identifying characteristics they may exhibit. These characteristics include innovativeness, likelihood for early adoption (Schreier & Prügl, 2008), product knowledge (Marchi, Giachetti, & De Gennaro, 2011) and stronger competencies (He & Yu, 2010). Another recent method involves use of different expert referral strategies (Hyysalo et al., 2015).

In most past research, lead users have shown extra abilities over ordinary users including topic expertise or a need to excel in an area beyond regular competition. While these experts are valuable as lead users, recent work has shown that lead user like behavior may also be found in use cases where the product use is pushed to the extremes but not necessarily to achieve top performance but rather to be able to use the product given an extraordinary situation. Few such extraordinary situations are: having a decreased level of performance (Hannukainen & Hölttä-Otto, 2006; Raviselvam, Noonan, & Hölttä-Otto, 2014) or living in extraordinary conditions such as without modern technology (Srivastava & Shu, 2011) or in the developing world (Judge, Hölttä-Otto, & Winter, 2015). These past works report on groups of users in these special situations being able to articulate needs that the general population has either not yet realized or expressed. In this paper we build on this by explicitly testing a set of dimensions that may be helpful in finding lead user like behavior. The objective of this paper is to test three possible lead user dimensions by testing if people at the extremes of a given dimension are able to express needs that will also be needs of the general population. The tested dimensions are introduced next.

Lead user dimensions

We define three dimensions of extreme user or use condition that we propose can be useful in finding lead user like behavior of being able to express latent needs. Based on the previous work reported above, we present here three dimensions: age, ability and degree of development (Figure 1). Each dimension assumes a distribution of users or a characteristic of a user where the ordinary user is the middle of the distribution and the extraordinary users are at the either extreme. The users at the extreme ends of the distribution are assumed, as a group, to be more likely to exhibit characteristics typical to a lead user, or voice out needs not yet expressed by the ordinary user in the middle of the distribution. We do not claim the entire population at the extremes is a lead user but rather that the population as a group may act similar to a lead user.

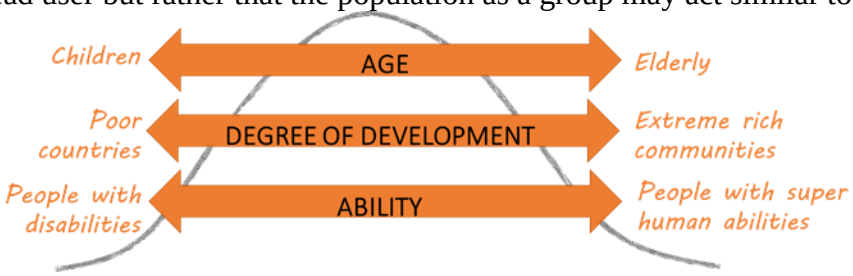

Figure 1 Three dimensions of lead user characteristics

Testing of lead user dimensions

We present three studies that investigate the dimensions introduced above. The ability dimension is tested with a case study on communication, age with a case study on everyday

activities and the degree of development is tested with a wheelchair case study. Each study is an independent study and thus presented separate, but they all follow a similar approach as illustrated in the diagram (Figure 2).

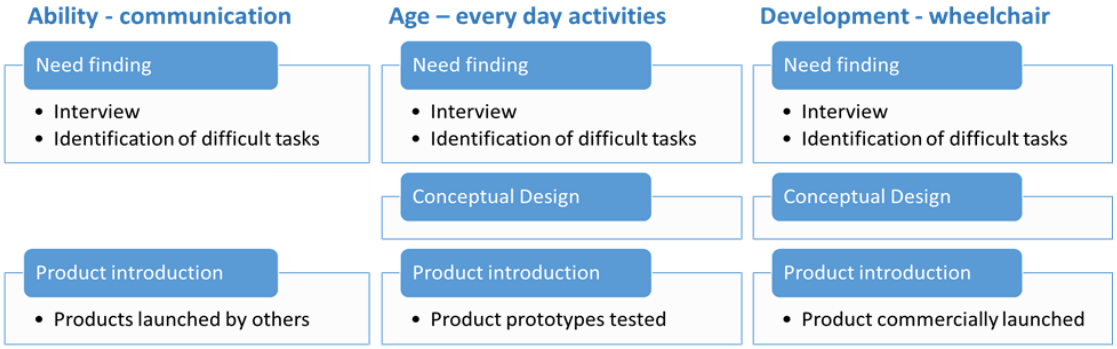

Figure 2 Overview of the research approach used in all three cases

The needs are identified independently with the hypothesized lead user like population as well as ordinary users. Need finding is focused on the difficulty of performing particular tasks. A need is an expressed dislike or difficulty about a product or related task. In all cases the needs are incorporated into conceptual or commercial products. The needs are compared for similarity and the needs voiced by the proposed lead user like group are checked for latency, i.e. are the needs that are only voiced by the lead user like group also preferred by the general population?

Ability

Given the amount of examples of the high level of ability, the ability dimension is tested at the other end of the distribution, namely with people with disabilities. The study here is reported in detail elsewhere (Hannukainen & Hölttä-Otto, 2006) but revisited here with a new angle of testing the proposed dimensions.

1.1.1 Methodology

Two different groups of mobile phone users with disabilities were compared with ordinary users with no reported disabilities: people with severe hearing and visual impairments (Table 1).

Table 1 Participant profiles for the communication study

Disability type	number	Gender	Age range
Visual impairment	5	2 female; 3 male	34-58
Hearing impairment	3	1 female; 2 male	25-33
None	3	1 female; male	29-60

The participants were given a photo diary task and instructed to take a picture using the given disposable camera of “everything you use for communication, or use for receiving and transmitting information”, i.e. newspaper, alarm clock, radio, mobile phone, signboards, etc. for a period of one day. The participants with visual impairments were trained on camera use. The photo diary results were later discussed with each participant. An independent interpreter was used to aid with the people with hearing impairments. In addition, the participants were asked to perform common tasks on their personal mobile phones including finding a phone that is on silent mode, leaving a voice mail message and sending a text message. The ordinary users, participants with no reported disability, were situationally disabled to mimic the situations found in the interviews.

1.1.2 Need similarity

Both people with disabilities and ordinary users actively use the same three devices for communication and handling information: mobile phone, television, and computer. Sources of information reported by all included the above devices as well as navigation related products such as maps and traffic signs.

All ordinary users articulated situations, when use of mobile phone is difficult because of not being able to hear well. These included traffic noise and rock festival. Further, all users mentioned the importance of a good keypad. One ordinary user hoped for a keypad that could be used without looking. One participant with visual impairment described a problem when navigating outdoors. He is able to notice signboards but not able to see what is written on them. He suggested image recognition as a solution to this problem.

In the task assignment we recorded if the participant succeeded in each task or not (Table 2). We find that the participants with and without disabilities performed similarly. The key differences were either due to luck, such as guessing correctly when a voicemail is ready for recording and in one case a situationally disabled (darkness) participant noticed the blinking light and was thus able to find phone.

Table 2 Success rate for each task by the different types of participants

Task	Users successfully completing the task	
	Ordinary users in complete darkness	Users with visual impairment
Finding a silent phone, when not holding it, and answer the call?	0/3	0/3
Finding a ringing phone, when not holding it, and answer the call?	3/3	3/3
Keypad locked, unlocking it and make a call?	2/3	3/3
Keypad unlocked, making a call?	3/3	3/3
Keypad unlocked, sending a text message?	3/3	3/3
Task	Ordinary users in noisy environment	Users with hearing impairment
Finding a ringing phone, not holding it?	1/3	0/3
Incoming call, finding the phone if the phone in a pocket or purse? (phone vibrating)	2/3	3/3
Incoming text message, finding the phone if the phone in pocket or purse? (phone vibrating)	2/3	3/3
Making a call?	3/3	3/3
Leaving a voicemail?	1/3	0/3
Send a text message?	3/3	3/3

1.1.3 Need latency

At the time of the research it was not further investigated if the unique needs identified only by the users with disabilities would be latent needs also for the ordinary users. The two needs speculated and reported at the time, in 2006, were the need to have a camera on both sides of the phone for both photo taking and video calling (in sign language); and a need for image to speech interpreter that could identify unknown signs etc. Now in 2016, it is evident that both of these needs were needs also in the general population as both types of mobile phone applications can be found and are used by all types of people.

Age

Both children and elderly qualify as the extreme end of the age dimension. To be able to obtain consent from adults, elderly was chosen as the test population. The term 'elderly' is used to refer to participants over the age of 65. The needs of the elderly are contrasted against the general population within the age range of 21-55. People between 50 and 65 were excluded to allow for a clear difference between the general population and the elderly given the personal aging progression of each individual.

1.1.4 Methodology

The study was split into two main phases (Phase 1 and Phase 2) and a design phase in between. Phase 1 identified the needs associated with selected day to day tasks. This was followed by an iterative design phase. In Phase 2 the design preference of elderly and general population was recorded. To test involving elderly as potential lead users and to avoid any bias of the general population, the general population was not approached until the study was completed with the elderly. Participant profile details for the entire study was as listed in Table3.

Table 3 Participant profiles for the Age study

	Phase	Number	Gender	Age range
Elderly	Phase 1	34	26 female; 8 male	65-92
	Design Phase	25	21 female; 4 male	66-94
	Phase 2	30	21 female; 9 male	65-89
General Population	Phase 1	34	9 female; 25 male	21-40
	Phase 2	30	5 female; 25 male	21-40

Each participant was given a questionnaire with a list of 19 tasks and were asked to choose the tasks they disliked the most. The questionnaire listed simple day to day tasks including opening a sealed water bottle and using a manual can opener. It included large images of each task for the ease of understanding among elderly. The questionnaire was also used as an interview guide if the participants preferred that over filling it out themselves.

Four products were redesigned based on the needs of the elderly. As mentioned earlier, needs from general population were collected only after finalizing the redesigned products. Once the products were designed, both populations were asked to select the product they would buy if given the particular options. The prototypes were presented together with a mock-up of a current solution and a decoy solution in order to not bias toward any one type of solution for other reasons and preference toward the design itself. The decoy solution (having a dent under the pull tab) provided for the soda can was later considered as a redesigned soda can. This was because, the decoy solution inadvertently also alleviated the need expressed by the elderly. The study was ongoing and had to continue without providing a decoy option for the soda can.

1.1.5 Needs similarity

As it can be seen in Table 4 the elderly and the general population face many similar difficulties in everyday tasks including making their bed or reading the list of ingredients on a package. However, some of the tasks were reported to be of opposite difficulty level. For example, while 50% of the general population found sewing a basic stich difficult, only 15% of the elderly faced the same difficulty. And on the contrary while 35% of the elderly disliked opening soda cans, only 6% of the general population reported the same. We conclude that some of the differences are due to differences between the abilities and preferences between the populations and some may be due to familiarity with the task.

Table 4 Difficulty of everyday tasks (sorted based on decreasing level of difficulty by the elderly)

Tasks	Percentage of people who felt the task was difficult	
	General population	Elderly
Opening a soda can	6 %	35 %
Reading ingredients or other details from a pack	29 %	32 %
Opening a sealed waterbottle	12 %	26 %
Opening large jars	29 %	26 %
Carrying laundry basket	15 %	24 %
Tying shoe laces	26 %	24 %
Preparing food(Difficulties while using the utensils)	35 %	21 %
Atm	9 %	18 %
Picking up a coin off the floor	26 %	18 %
Flipping socks	6 %	15 %
Making their bed	18 %	15 %
Pulling a plug out of an outlet	12 %	15 %
Sewing a basic stitch	50 %	15 %
Opening sugar packets	9 %	12 %
Holding a pen or pencil	0 %	6 %
Opening a zip-loc bag	9 %	6 %

We thus cannot fully conclude anything regarding the need similarity, but in order to continue to investigate the possibility that the elderly may have identified needs that are not yet realized by the general population, we selected four cases to pursue and developed solutions for those. We selected opening a soda can and a water bottle, sewing a basic stitch, and making the bed. This selection includes everyday tasks that represent all three types of trends from the need similarity finding (equal difficulty, elderly find difficult general population not and general population find difficult but elderly do not).

1.1.6 Need latency

In Phase 2 we analyzed if the products designed based on the needs by elderly were preferred also by the general population. Figure 3 shows examples of these redesigned water bottle including the mock-up of the current solution and the decoy.

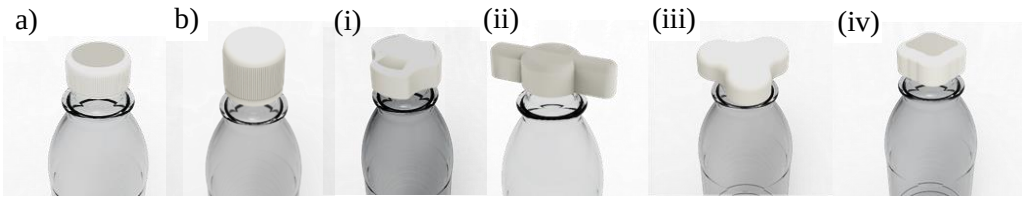

Figure 3 a) Existing water bottle cap, b) Decoy water bottle cap, Redesigned water bottle caps: (i) 3 fold (ii) Double extension (iii) Triple extension (iv) Square

Figure 4 displays the percentage of participants from each group who preferred those products. The choice by both populations was distributed across all options. Though the product with maximum preference differed between each group, it is evident from Figure 4 that on average, 89% of the general population and 90% of the elderly would prefer a redesigned product over an existing one. In particular, while only 6% of the general population mentioned opening a soda can to be a difficult task based on its design, none of them chose the existing soda can design when given an option. This shows that products designed based on the needs of the elderly are preferred also by the general population and thus the elderly were able to identify latent needs, making them a potential choice for lead user like population.

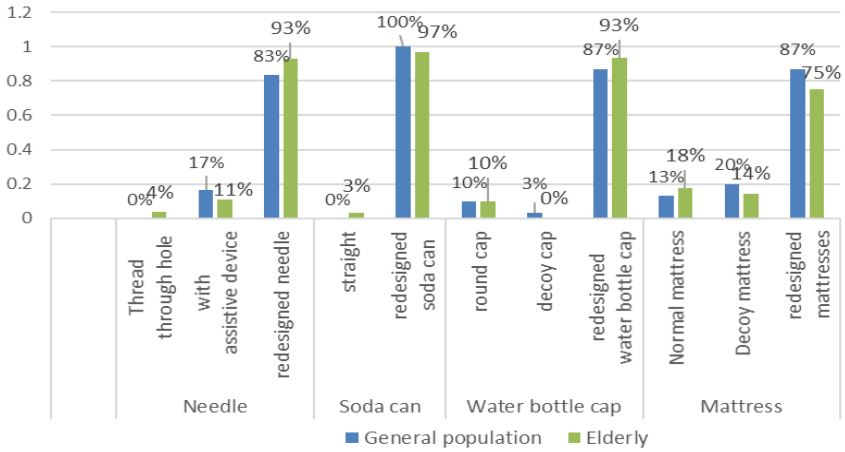

Figure 4 Preference percentage for redesigned products

Degree of Development

To investigate the dimension of the degree of development, we chose to compare the needs between a developing and developed world. The details of this study are reported elsewhere (Judge *et al* 2015), but the data is revisited here in order to test the dimension along the other two dimensions proposed here.

1.1.7 Methodology

The user needs from the developing world were collected for another study regarding a wheelchair development (A. G. Winter, 2013; A. G. Winter et al., 2010; A. G. Winter, Bollini, DeLatte, O'Hanley, & Scolnik, 2009; A. G. Winter et al., 2012). These needs were reanalyzed for this study. The past work resulted in a wheelchair (Leveraged Freedom Chair, LFC) that is only available for purchase in India. This LFC and its features, specifically developed for the developing world was used to gauge the interest of users in the developed world towards the same.

Table 5 Participant profiles for the wheelchair study

User type	Number
Developing world user (legacy data)	125
Developed world user (survey)	31
Developed world user (contextual interview)	23

The developed world needs were collected using an online survey and contextual interviews (Table 5). The same survey was also used to complement contextual interviews. During the contextual interviews the users were able to either ride or watch the previously developed LFC based on their preference. In case a user preferred not to write the responses were transcribed by the research team. Also any additional comments were recorded.

1.1.8 Needs identified

After clustering, we identified 23 separate needs from the two populations. Out of these, nine were mentioned only by the users in the developing world, the potential lead user like population. One need was identified only by the users in the developed world. Thirteen of the needs are identical between the two populations indicating some but not significant similarity.

1.1.9 Need latency

If the users in the developing world could act similar to lead users, they should have identified needs that are also important to the users in the developed world. In order to investigate this, we prompted the users in the developed world with specific features of the LFC that incorporated the needs identified in the developing world. In one question they were asked to indicate how commonly they faced an issue that was originally identified in the developing world such as rolling over rough ground (Table 6). All scenarios based on the developing world were identified at least as occasionally frequent issues faced also in the developed world.

Table 6 Frequency of facing an issue (1 – very rarely, 2 - rarely, 3 – occasionally, 4 –frequently, 5 – very frequently)

Possible issue faced when using a wheelchair	Average rating
Roll over rough ground w/o getting stuck	4.22
Reduce effort to go up an incline	4.06
Propel a longer time without tiring	3.86
Push and brake w/o touching the handrims	3.75
Propel faster on a flat or downhill	3.50
Repair mobility device at a bike shop	3.36

The users in the developing world were also asked to select features they would like to see in order for them to buy an LFC or a similar product, if available to them. This was part of the need finding for this study but also an effort to redesign a novel wheelchair for the developing world based on the LFC (Judge et al., 2015). The features to select from were:

- Breaks less often
- Easily repaired
- Affordable out of pocket
- Insurance coverage
- Can be primary device
- Compatible with ability/ functional level
- Appealing to personal style
- Easier on public transit
- Easier to stow for transport
- Easier to store at home
- Lighter to lift
- Maneuver in narrow areas
- Seating an postural support is more adequate
- I would take it as is
- I would never buy an LFC

The top three features listed in order of frequency of mention were affordability, reparability and compatibility with ability or functional level. The three least frequently mentioned options in decreasing frequency of mention were ease or riding on public transport, appealing style and the option of never buying such a device. The needs identified from each of these questions were merged with the needs identified earlier. Each of the needs previously only identified in the developing world was now also identified important by the users in the developed world. This is an indicator that those needs were, indeed, latent needs for the developed world users.

All the above provides evidence the users in the developing world may, indeed, be able to express needs that are not yet expressed by users in the developed world. As a further evidence, the wheelchair developed as part of the project (Judge et al 2015) was successfully launched via Kickstarter in late 2015 and now commercially available through Global Research Innovation and Technology (GRIT)[1].

Discussion

We set out to help latent need discovery by testing three dimensions of users or use cases to find out if people at the extreme ends of these dimensions would be able to act similar to lead

[1] http://gogrit.us/

users and identify latent needs. We tested the dimensions by comparing the similarity of the needs from the potential lead user like populations and the general population as well as investigated if the needs identified only by the people at the extremes of the dimensions were latent needs not yet expressed by the general population. We found mixed evidence for the need similarity. This was expected. The two populations are different but still use the same product. Thus many of the needs were different but some were also the same. However, in all cases we found that the people at the extremes of the three dimensions exhibited lead user like behavior and identified needs not voiced by the general population until specifically asked based on a need only voiced by the potential lead user. This supports the use of the dimensions as a guide to find lead user like behavior and consequently latent needs.

We do not assert that every person at these ends would be a lead user, rather we show that a group of them exhibits similar benefits as lead users. Further, we do not claim that designing for these extreme ends will always lead to novel innovations appreciated by all. We highlight the possibility of this happening and based on the evidence reported here recommend including the users at the extreme ends of these dimensions in regular product development as relevant.

We here showed evidence for three dimensions. For ability, we showed that people with sensory impairments were able to articulate needs otherwise not voiced by the ordinary users for communication devices. Electric toothbrush is an example of a common innovation that originally came from a need to enable people with motor skills issues to brush their teeth[2]. Yet in another category of products, toys, a somewhat recent hit toy Keepon[3], was originally designed to help children with autism. At the other end of the ability dimension there are multiple previous lead user studies on extreme athletes, for example, as reported earlier. In the age dimension, we showed evidence for a variety of everyday products and how the older extreme of the dimension can be helpful in identifying latent needs. Examples from the other end and also from other product categories include chewable medicine and supplements that are now available not only for children but also adults. For the degree of development there are multiple cases of reverse innovation where in a wide variety of product categories (including food and beverage, household supplies and farm equipment) an innovation was initiated in the developing world (A. Winter & Govindarajan, 2015). These examples indicate the potential these dimensions may have in identifying latent needs in also other product categories.

The case studies covered range of products and also varied in type of organization or stage of development – one is for a large multinational corporation, one is a conceptual development only and one is a start-up. This highlights the fit to many different types of corporate environments and business types as well as shown encouraging signs just how widely these dimensions could be applicable.

Limitations of this study include testing only a single example in each dimension and only testing one end of the dimension and thus further work is needed to further validate the results and their generalizability. Furthermore, there are likely other dimensions. For example expertise has already been shown (Hyysalo et al., 2015) to be helpful in identifying lead users. Could the other end of the spectrum also lead to latent need discovery? The exhaustive list of dimesions as well as the validation of them remains a future study.

[2] http://recomparison.com/comparisons/101617/electric-toothbrush-vs-normal-toothbrush-which-is-better/
[3] http://www.mykeepon.com/story

References

Hannukainen, P., & Hölttä-Otto, K. (2006). Identifying Customer Needs—Disabled Persons as Lead Users. *Proceedings of ASME IDETC, Philadelphia, PA, Sept*, 10-13.

Hauser, J. R. (2008). Note on the Voice of the Customer: MIT, Cambridge, MA.

He, G., & Yu, J. (2010). *Identify Lead Users by customer competence.* Paper presented at the Industrial Engineering and Engineering Management (IEEM), 2010 IEEE International Conference on.

Hyysalo, S., Helminen, P., Mäkinen, S., Johnson, M., Juntunen, J. K., & Freeman, S. (2015). Intermediate search elements and method combination in lead-user searches. *International Journal of Innovation Management, 19*(01), 1550007.

Judge, B. M., Hölttä-Otto, K., & Winter, A. G. (2015). Developing World Users as Lead Users: A Case Study in Engineering Reverse Innovation. *Journal of Mechanical Design, 137*(7), 071406.

Marchi, G., Giachetti, C., & De Gennaro, P. (2011). Extending lead-user theory to online brand communities: The case of the community Ducati. *Technovation, 31*(8), 350-361.

Raviselvam, S., Noonan, M., & Hölttä-Otto, K. (2014). *Using elderly as lead users for universal engineering design.* Proceedings of the International Conference on Universal Design, UD 2014 Lund, Sweden, June 16–18, 2014.

Schreier, M., & Prügl, R. (2008). Extending Lead-User Theory: Antecedents and Consequences of Consumers' Lead Userness*. *Journal of Product Innovation Management, 25*(4), 331-346.

Srivastava, J., & Shu, L. (2011). *Encouraging environmentally conscious behaviour through product design: the principle of discretization.* ASME 2011 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference.

Von Hippel, E. (1986). Lead users: a source of novel product concepts. *Management science, 32*(7), 791-805.

Von Hippel, E., Thomke, S., & Sonnack, M. (1999). Creating breakthroughs at 3M. *Harvard business review, 77*, 47-57.

Winter, A., & Govindarajan, V. (2015). engineering reverse innovations Principles for creating successful products for emerging markets. *Harvard business review, 93*(7-8), 80-89.

Winter, A. G. (2013). *Stakeholder and constraint-driven innovation of a novel, lever-propelled, all-terrain wheelchair.* ASME 2013 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference.

Winter, A. G., Bollini, M. A., DeLatte, D. H., Judge, B. M., O'Hanley, H. F., Pearlman, J. L., & Scolnik, N. K. (2010). *The design, fabrication, and performance of the East African trial leveraged freedom chair.* ASME 2010 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference.

Winter, A. G., Bollini, M. A., DeLatte, D. H., O'Hanley, H. F., & Scolnik, N. K. (2009). *The design and testing of a low-cost, globally-manufacturable, multi-speed mobility aid designed for use on varied terrain in developing and developed countries.* ASME 2009 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference.

Winter, A. G., Bollini, M. A., Judge, B. M., Scolnik, N. K., O'Hanley, H. F., Dorsch, D. S., . . . Frey, D. D. (2012). *Stakeholder-driven design evolution of the leveraged freedom chair developing world wheelchair.* ASME 2012 International Mechanical Engineering Congress and Exposition.