5.1

Guidelines to design for dynamic and diverse use situations

Exploring the who, where and why of product use

Mieke van der Bijl-Brouwer

Summary

The aim of this study is to support product development teams in dealing with the variety of situations in which products are used, so-called dynamic and diverse use situations. Dealing with varying use situations in the design process is difficult because it is hard to predict the situations in which a product will be used, to anticipate what will happen when the product encounters those situations and to generate solutions for conflicting requirements. Our retrospective study of three design projects in practice showed that knowledge of dynamic and diverse use situations often remains implicit and is not shared between members of a product development team. This can have a negative effect on the validity of usability evaluations and can give rise to difficulties in decision-making with regard to product usability. We therefore developed a set of guidelines to support teams when dealing with dynamic use in the design process. The guidelines were developed iteratively and evaluated in seven student projects. They enable teams to create an explicit frame of reference of use situations which can be applied to contextualize usability evaluations; a 'dynamic use mindset' which inspires solution generation; and a shared vision on product use which supports decision making.

< American tourist Brian Wilson stood on a street corner in Amsterdam for 73 minutes and captured what to him was an amazing diversity of bicycle riders and use [1]

YouTube
Watch a 2½ minute animated summary of this research:
http://**bit.ly/ddus-summary**

Research & Findings

Author bio

Mieke van der Bijl-Brouwer graduated *cum laude* in Industrial Design Engineering at TU Delft in 2002. She is now an Assistant Professor at the University of Twente and researches and lectures on subjects in the field of usability, user experience and scenario-based design. She was awarded her PhD for her research on 'Design for Dynamic and Diverse Use Situations' *(cum laude)* in September 2012. She also contributed to the development of the Envisioning Use technique (see subchapter 4.2)

Mieke's PhD was supervised by Associate Professor Mascha van der Voort and Professor Fred van Houten.

Introduction

As opposed to tailored products, industrially manufactured products are used by varying users, for varying purposes in varying contexts. I have termed this dynamic and diverse use situations (DDUS). These situations refer to the change of situations over time for one product, for example, one day you might use your bicycle to quickly cycle to university to get to a lecture on time, while the next day you might use it to transport your groceries from the supermarket to your home. DDUS refer to the change of situations in time and space for different versions of the same product. For example, someone else might possess the same type of bike but only use it for recreational purposes, for example cycling with friends.

Design for DDUS is difficult because it is hard to:

> predict the variety of use situations a product will encounter: use situation analysis;
> anticipate what kind of issues will occur when the designed product interacts with these situations: use anticipation;
> deal with conflicting requirements from the different use situations in one design: solution generation.

The relation between the different aspects of design for DDUS – use situation analysis, use anticipation and solution generation - is illustrated by the following example (See Figure 1). Designers of smart phones will undoubtedly do a great deal of research on who uses or would like to use smart phones, for which purposes, and under which circumstances. Apple designers might have expected that people would use the iPhone outside, also in cold weather (use situation analysis). However, that Korean people would use sausages to operate the phone in cold weather (use anticipation) was probably unforeseen! As the example demonstrates, each specific use situation can require different product characteristics. In this case, the problem can be solved by providing an accessory for the iPhone, such as a special glove (solution generation).

Another difficulty of design for DDUS is that decisions need to be made on which use situations will be taken into account and which solution proposals will be chosen to suit these use situations. To make these decisions in a product development team, team members should have a shared understanding of use situations and related use issues. The importance of considering the variety of use situations is recognised in the main literature on usability. Many techniques are available to analyse use situations, such as interviews and observations [2], probing [3, 4] and after sales feedback [5]. Furthermore, the literature often mentions that the test conditions of usability evaluations should represent

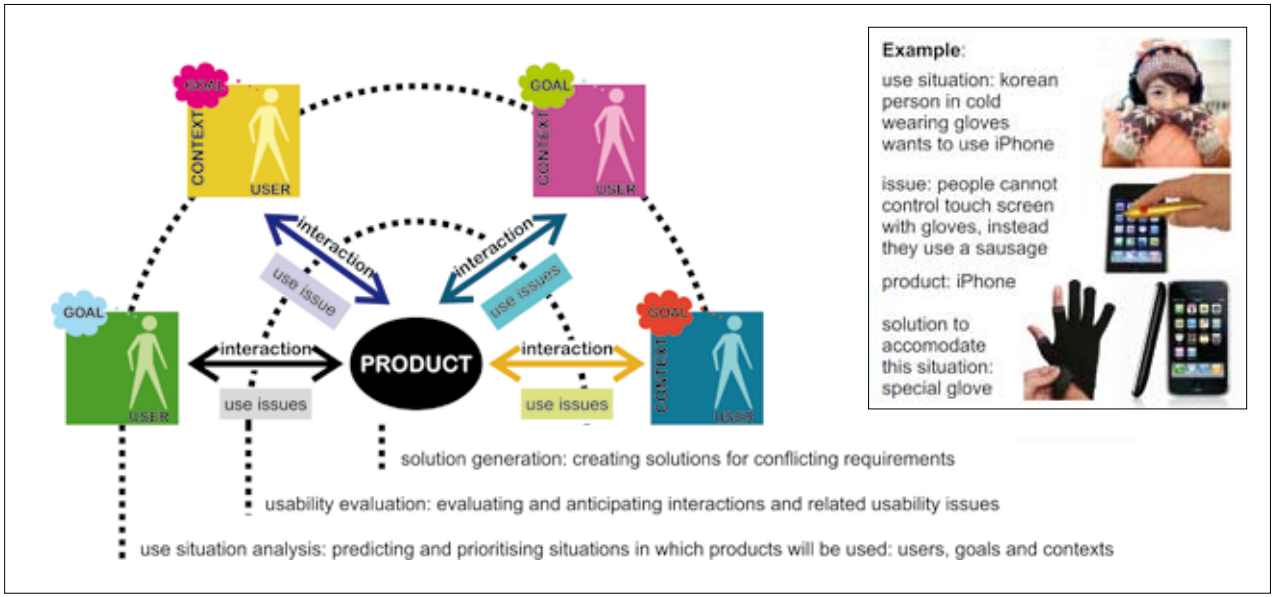


Figure 1: explanation of the different theoretical problems when designing for diverse use situations.

the actual user, goal and environment [6, 7]. However, in spite of these acknowledgements, little guidance is available on how an analysis and specification of intended use situations can lead to a frame of reference for usability evaluations. The purpose of our study therefore, was to develop a support tool aimed at filling this gap.

Research method

To analyse how designers in practice currently deal with DDUS, a retrospective study of three real-world design projects was conducted. Information about the projects was gathered by means of group and individual interviews with members of the development team of a product with varying use situations.

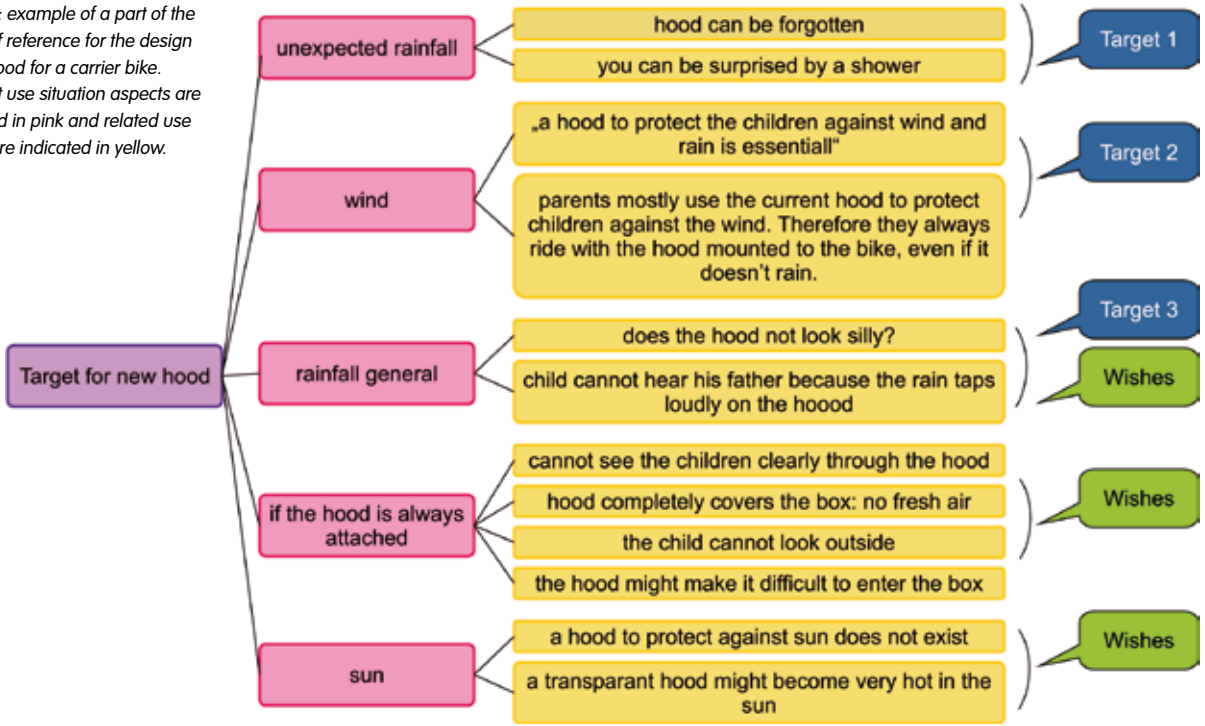
Our analysis led to the problem definition, which we used as input for the development of a support tool which enables designers to deal with knowledge of DDUS in the design process. The tool consists of the Envisioning Use technique, which is discussed in Chapter 3.2, and a set of guidelines. The guidelines were developed iteratively in two educational projects, in which students designed for a real client. In the first project, four student teams designed a carrier bike for Bongo Innovations BV. The design processes of both projects were analysed by means of document analysis and a group interview. The guidelines were then revised based on these insights. In the second project, three student teams, with the help of the revised guidelines, redesigned an Airfryer for Philips. An evaluation of both projects led to a final workbook with guidelines.

Figure 2: the design of the carrier bike with a hood, which can be used in varying weather conditions to protect children.

Results

The goal of the guidelines is to make designers more aware of DDUS, stimulate designers to analyse DDUS, explore the consequences of DDUS, apply the use situations consistently in the design process, and create a shared vision with regard to DDUS within product development teams.
The guidelines are documented in a workbook, which also explains how they can be applied. A summary of the guidelines is included in this section. The design process of a hood for a carrier bike (see figure 2), by Industrial Design Engineering students at the University of Twente, is used to illustrate the application of the guidelines.

Figure 3: example of a part of the frame of reference for the design of the hood for a carrier bike. Relevant use situation aspects are indicated in pink and related use issues are indicated in yellow.



The most important guidelines are:

> Make all members of a design team aware of dynamic use and create a common mindset by means of the Envisioning Use technique.
> Keep track of a consistent explicit frame of reference with use situations and related issues throughout the design process.
> Create this frame of reference by means of exploring use issues related to chosen use situations.
> Apply the frame of reference in usability evaluations.

This 'frame of reference' is an overview of all relevant use situations that a product can possibly encounter and also lists the use issues such as usability or user experience issues that occur when a user and product interact in those specific circumstances. An example of a part of a frame of reference is shown in Figure 3. This shows how different weather conditions (use situations) relate to specific use issues for the design of a hood for a carrier bike.

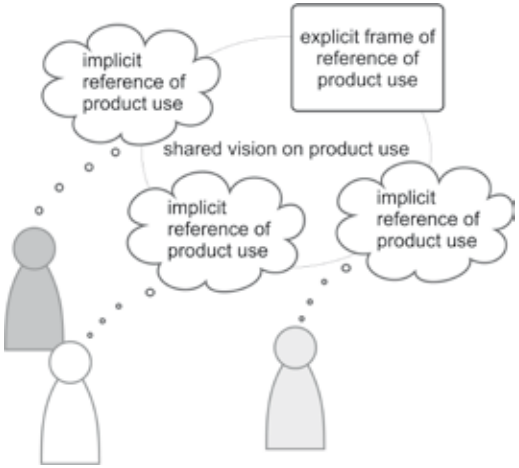


Figure 4: The implicit frames of reference of product use (ideas about possible use situations and issues) of members of a product development team should be aligned with each other and with an explicit frame of reference, to create a shared vision on product use.

The shared vision on product use

Creating a shared vision on product use means that all members of a product development team have the same mindset or 'implicit frame of reference' of relevant use situations and related use issues. These implicit frames of reference should be aligned with each other and with the explicit frame of reference (see figure 4). The best way of achieving this is to create an explicit frame of reference of product use together, as presented in the Envisioning Use technique (subchapter 4.2).

The explicit frame of reference

An explicit frame of reference includes two types of information: information about the diverse situations in which products are used, and information about the interactions between products and these use situations (see Figure 5). When a product is part of a specific use situation, this will result in an interaction with certain qualities: the use issues. Use situation aspects concern user characteristics, their goals and the context of use (see also Chapter 1.2). For the design of the carrier bike, examples are the physical characteristics of the cyclist, why the cyclist prefers a carrier bike to a car, types of luggage or passengers, road conditions, weather conditions etc. Use issues can be related to performance, usability or user experience. For example, if the box of the carrier bike is large enough to bring all preferred luggage (performance), if the hood is easy to adjust (usability) or if the children are happy to sit in the box (user experience). Besides this 'use knowledge', the frame of reference contains a target which defines which use situations and issues will be accounted for throughout the design process.

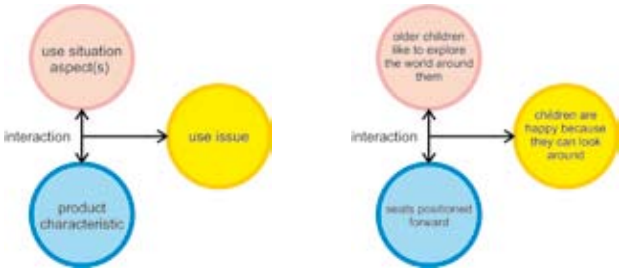


Figure 5: relation between use situations, use issues and product characteristics and an example

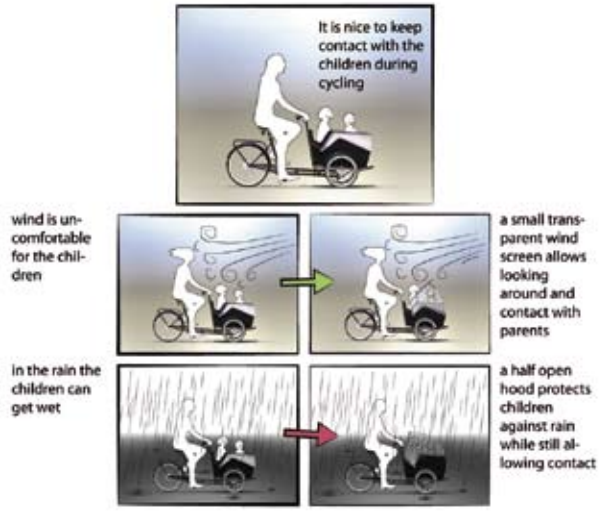


Figure 6: The design of the hood presented in the frame of reference of different weather conditions (use situations) and resulting experiences for parents and children (use issues).

Since the frame of reference can consist of a large collection of use situations and issues, it can easily contain too much information to deal with in communication or solution generation. We therefore propose the use of different views: a complete view which can be used as a check list in usability evaluations, and the simplified priority view which shows the most important situations and issues in one page, and which can be used to support communication and inspire solution generation. Figure 6 shows the design of the hood in a prioritized frame of reference of different weather conditions with explicitly mentioned use issues, represented in a storyboard format.

Creating the frame of reference

To create and update a new frame of reference, teams can employ different design activities. They can distinguish between internal activities, aimed at exploring how use situations relate to use issues based on assumptions, and external activities, aimed at exploring factual use situations and evaluating solution proposals in those use situations. Internal explorations include techniques like self-testing design proposals, scenario analyses, and the Envisioning Use technique. Internal explorations are important because they can easily be applied in an iterative design process: a solution can be created, explored quickly as to how it relates to different use situations, adjusted etc. Another benefit of internal explorations is that it guides the external activities by making gaps in factual knowledge or product use explicit. External explorations are activities aimed at gathering insights in the relevant use situations and issues for comparable products, for example by consulting online reviews or observations of use of comparable products. These explorations of current use lead to insights that can be extrapolated to future use.

Finally, evaluations of design proposals in probable use situations can give insight in factual use issues. Since each

activity can be used to add, verify or remove information on product use, the frame of reference evolves in the course of the design process.

Applying the frame of reference in usability evaluations
The main advantage of a complete explicit frame of reference is its application in usability evaluations. Targeted use issues in the frame of reference can be translated into research questions for usability evaluations. For example, a question for the design of the hood for the carrier bike could be: 'Can children communicate sufficiently with parents while seated in the box?'
The most important function of the frame of reference when planning usability evaluations is that it helps to set proper test conditions. To increase the 'external validity' of usability evaluations, the test conditions of these evaluations should reflect actual use situations as much as possible [8, page 241]. The frame of reference should give insights into what these actual use situations are. For example in the case of the carrier bike, apart from testing in different weather conditions, it makes sense to invite children of varying ages for a user test because their needs for communication with parents while seated in the box can be assumed to differ.

Benefits

The ultimate goal of the guidelines is to develop products with a high level of usability in the targeted diverse- use situations. This can be achieved by, on the one hand, creating design proposals with a high level of usability and, on the other hand, by better decision-making processes with regard to choosing the most appropriate solution and target use situations. The latter is achieved by stimulating the creation of a shared vision on product use. The former is achieved by firstly stimulating the designer's awareness of dynamic and diverse use situations and thereby creating a mindset which can inspire solution generation. Secondly the guidelines support the creation of solutions that better fit diverse use situations by stimulating the integration of use situations in the usability evaluations, which in turn can lead to use situation-specific recommendations for the creation of solutions.

The activities mentioned in the previous sections are not meant to replace current design activities. On the contrary, they refer to activities that often implicitly – already occur in practice. The added value for design for DDUS is that the relation of these activities to the frame of reference with DDUS now becomes more apparent. The guidelines can therefore be applied in existing design approaches.

Validation

The guidelines have been evaluated in educational projects, as described in the research method. A validation in student projects enables close observation of the design process by multiple respondents. Their evaluations have led to the conclusion that working with an explicit frame of reference supports the generation of more focused research questions in usability evaluations, and offers opportunities for setting up more valid test conditions. A valuable approach to generating the explicit frame of reference is combining the exploration of the relation between use situations and usability with the verification of this relation. Moreover, the joint creation of this explicit frame of reference (such as within the Envisioning Use workshop) has led to a shared vision on product use in the design teams. Students highly valued this shared vision on product use, and found it beneficial in their team decision-making processes and in their creative process of solution generation. The workbook format of the guidelines did not always have the intended effects. Therefore future research will be aimed at developing other formats to improve the usability of the guidelines.

Limitations

Applying these guidelines will not lead to a company starting

Figure 7: Examples of the application of the guidelines to the design of a carrier bike: creating a first frame of reference in the Envisioning Use workshop, exploring use of a current solution, the product use mind map and a digitized version of the complete frame of reference.

to create usable products all of a sudden. The guidelines can only be applied successfully if two conditions in the company context (see also Chapter 2.1) are met, namely that usability is already considered an important issue by the product development team, and that the team is familiar with common usability methods such as usability evaluations.

As mentioned, the framework has currently only been evaluated with students, most of whom have less design expertise than practitioners, and project circumstances differ from those in actual product development projects. These evaluations provided valuable insights, based on which the first iterations of the guidelines could be conducted. However, there are issues remaining to be explored which concern the application of the guidelines in product development practice, namely:

> Managing a frame of reference of use situations in combination with other references such as requirements and specifications;
> Creating a workable format for this frame of reference in design practice.

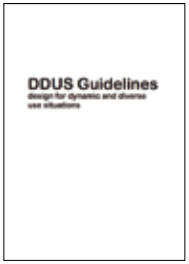
Therefore we need to further validate the workbook in product development and design practice.

Pieta van der Molen
Student Industrial Design Engineering

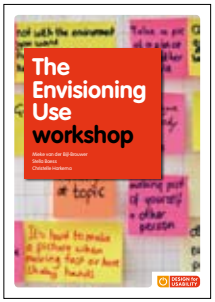
On applying the guidelines for DDUS in a master assignment Industrial Design Engineering

"The design for dynamic use guidelines were of great help during my research about the use and user experience of mobility scooters. A mobility scooter replaces walking, cycling and driving a car for people with impaired mobility and is therefore very diverse in use. The guidelines helped me to explore different aspects of the use of mobility scooters in different ways. By making these aspects explicit and thinking in use situations and use issues, it was easier to structure the large amount of information gathered. Moreover, it helped me to find and keep focus on what was important while designing new types of mobility scooters. With the help of storyboard scenarios, explaining the diverse use of the product ideas, possible future users were asked for their opinions. They immediately thought of themselves as driving the new devices. It resulted in very clear and specific feedback about how they might use and experience the new mobility scooters."

More information



Guideline workbook
This workbook describes and explains the guidelines to design for dynamic and diverse use situations
http://**bit.ly/ddus-guidelines**



Workshop manual
The Envisioning Use workshop manual describes how to set-up the workshop
http://**bit.ly/eu-booklet**

PhD Thesis
Exploring usability, design for dynamic and diverse use situations
http://**bit.ly/ddus-thesis**

Author homepage
Homepage of Mieke van der Bijl-Brouwer, highlighting education and research activities
http://**bit.ly/vanderbijl**

Contact

If you are interested in applying the guidelines in design practice, please contact the author for inquiries and support.

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Core publications

> Van der Bijl-Brouwer, Mieke: Exploring Usability, design for dynamic and diverse use situations, University of Twente, PhD thesis, 2012
> Van der Bijl-Brouwer, Mieke: Exploring design for dynamic use, proceedings of the international conference on engineering and product design education, 8 & 9 September 2011, City University, London, UK , 2011
> Van der Bijl-Brouwer, Mieke and van der Voort, Mascha C.: Strategies to design for dynamic usability in Proceedings of IASDR2009 Design Rigor & Relevance, Oct. 18-22, Seoul, Korea, 2009

References

1] B. Wilson. (2006, 10 September). Amsterdam Bicycles. Available: http://www.ski-epic.com/amsterdam_bicycles/index.html
[2] H. Sharp, Y. Rogers, and J. Preece, Interaction Design: Beyond Human-Computer Interaction, 2nd Edition ed. John Wiley & Sons, Ltd, 2007.
[3] B. Gaver, T. Dunne, and E. Pacenti, "Design: Cultural probes," Interactions, vol. 6, pp. 21-29, 1999.
[4] S. A. G. Wensveen, "Probing experiences," in Proceedings of the first international conference on Design & Emotion, Delft University of Technology, 1999.
[5] J. I. van Kuijk, H. Kanis, H. H. C. M. Christiaans, and D. J. van Eijk, "Usability in Product Development Practice: After Sales Information as Feedback," in Proceedings of IASDR07, Hong Kong Polytechnic University, 2007.
[6] J. Rubin, Handbook of usability testing. New York: John Wiley & Sons, 1994.
[7] N. Bevan and M. Macleod, "Usability measurement in context," Behaviour and information technology, vol. 13, pp. 132-145, 1994.
[8] P. W. Jordan, B. Thomas, B. A. Weerdmeester, and I. L. McClelland, Eds., Usability evaluation in industry. Taylor & Frances, 1996, p.^pp. Pages.