Including User Needs in Product Development

Markus Modzelewski*,Michael Lawo*,Pierre Kirisci†, Joshue O'Connor‡, Antoinette Fennell‡, Yehya Mohamad§, Svetlana Matiouk§, Markus Valle-Klann§, Haluk Gökmen¶
*University of Bremen
{modze, mlawo}@tzi.de
†BiBA GmbH
kir@biba.uni-bremen.de
‡National Council for the Blind (NCBI)
{joshue.oconnor, antoinette.fennell}@ncbi.ie
§Fraunhofer FIT
{yehya.mohamad, svetlana.matiouk, markus.klann}@fit.fraunhofer.de
¶Arcelik A.S. Karaagac
haluk.gokmen@arcelik.com

***Abstract*—The development of products that are accessible to the largest possible group of users can be regarded as a major challenge for manufacturers of consumer products. It is therefore crucial, that the product development process is supported by practical methods and tools that can help incorporate these essential human factors in early phases of the development process. Ergonomic evaluation and user testing with real users are user centred design methodologies often conducted by companies that are not only complex, but can be very time and cost-intensive. As an alternative approach virtual user models (VUM) have been proposed for supporting the early phases of the product development process. In this paper we will present the model-based design approach of the European research project VICON supporting inclusive design of consumer products particularly at the early stages of product development.**

I. Introduction

In the last years technology has evolved including new problematic issues which popped up besides an exponential growth of functionality. With continuous development of computers, interfaces can have analogously more capabilities. For instance mobile phones are not just used as phones any more, they can be used to browse the internet, to read and write emails or to control the tv. Smaller and more efficient electronic components can be included into products, resulting in an unlimited-appearing functional expansion. The fascination about new possibilities often obscures the fact that technology can also create new burdens and complexity to end users[1]. Especially a coupling of different functionalities into single devices can be very inefficient due to acceptance and usability by the end users.

This development can be seen as a two-edged sword, on the one side new functionality and features increase the product value, on the other side all new functionality and features must be included into a feasible and recognizable product, mostly resulting in a major redefinition of the product as e.g. happened with mobile phones into smart phones.

More sophisticated interfaces like touchscreens with haptic feedback are capable of a realization of multiple functionalities but the user needs to adapt and learn how to operate it properly. This issue will most likely result in a lower acceptance by especially elderly people or people who do not explicitly require such a system.

Newell et. al. described a different approach, including user needs and requirements of elderly and disabled people in the design process of products[2]. This paper extends this approach in a phase based software solution for designers to improve context awareness and designers' empathy for these target user groups within the VICON project[1].

A. Design Recommendations

Existing user studies and projects contain information about problems and issues regarding different kinds of user interfaces. These guidelines often refer to a textual output of theories and data due to experience dealing with user needs of impaired customers of products. During the product development process designers need to have an as good awareness about user needs to deal with all problematic issues regarding the usage of each designed product.
To maintain this awareness, the connection between the designers and customers of their products needs to be revised and optimised. Referring to the product development process a supporting system will be used to present and adapt issues of these guidelines and additional personal experience.
The following example recommendation presents one issue derived from the tiresias website[3].

> "Visual markings on the keys should be characters at least 4 mm high and should have good contrast with the colour of the key (e.g. white characters on matt black keys)" (see [3])

This sentence defines already two very different issues with respect to requirements and user needs:

1) Visual markings on the keys should be characters at least 4 mm high
   This item defines an already specified minimum value for a font size of characters on keys. Thus it refers

[1] see http://www.vicon-project.eu

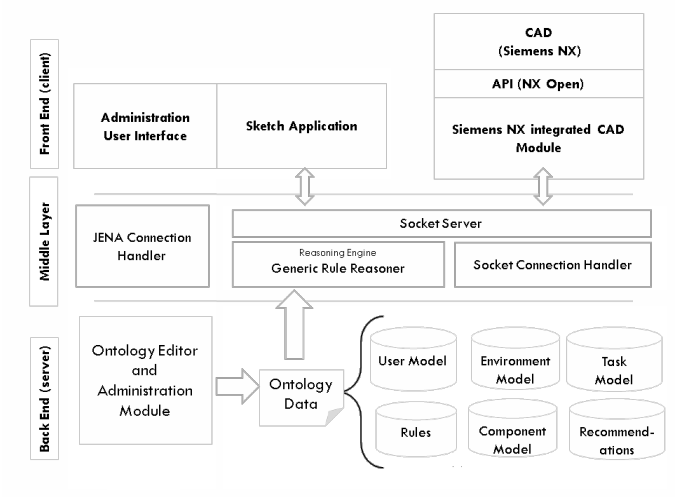

Fig. 1. System architecture focusing upon impact in product development phases

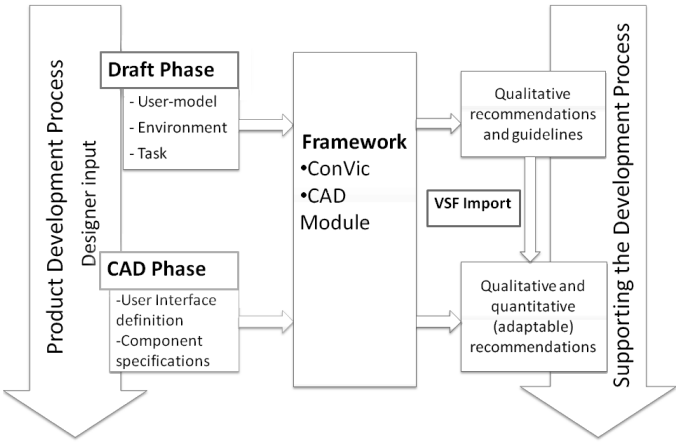

Fig. 2. Designer input of sketch design and cad phase.

to a nominal value, this issue type is defined as a **quantitative recommendation**.

2) Good contrast with the colour of the key (e.g. white characters on matt black keys)
With respect to nominal values, this issue refers to an abstract view on the product design interface. During the product development process it can be very problematic to adapt to these issues automatically due to all different assertions of natural language. This type of information is referred to as **qualitative recommendations**.

Due to the differences between qualitative and quantitative recommendations, both types must be adapted and used separately. Qualitative recommendations, with respect to the fact of natural language and their abstractness, must already be included as early as possible into the design process. Regaring the concrete values described in quantitative recommendations, they are especially important and used in the cad phase, where already a first virtual prototype of the final product is available.

II. Service Oriented Architecture

Figure 1 shows an overview of VICON services and framework parts[4]. The VICON front end allows the user to test their product by creating a virtual user, an environment as well as a number of tasks, which reflect activities a user can perform with the product.

The recommendation system can be accessed in the sketch phase and the simulation system in the CAD phase. Afterwards an evaluation can be conducted and reports generated. The middleware services deal with all incoming and outgoing connections and provide relevant data to the different applications. Recommendations are marked with a phase attribute. Any recommendation instance consists of a user model-, environment-, task- or component rule, defined as Generic Rule Reasoner Rule Sets[2]. The backend services provide the data and the algorithms to implement the functionalities; databases and components comprising the VICON system phases. Figure 2 presents the input and output of the system for sketch design and cad phase. Each user input relates to different information about the product and results in different recommendations. Thus each input is used independently as described in the next section. For the evaluation of the product, already the virtual protoype is available and no user input is necessary.

[2]Inference Rule Sets of the Generic Rule Reasoner of Jena, see http://jena.sourceforge.net/inference/#rules

III. Recommendation System for the Sketch Phase

The data model of the system is based on data types and classes of the ontology. The Virtual User Model (VUM) consists of 5 classes:

1) User Model class, where all information about a virtual user including physical impairments or limitations are stored. The predicates for this model were achieved through user studies. User models are divided into eight WHO ICF[**?**] based subgroups (Profiles), where for every criterion the profiles are divided into different levels of impairments. Additionally there are mixed profiles describing the group of elderly people with a mixture of hearing, sight and manual dexterity impairments.
2) The Component Model class describes specific constituent parts of the product, called components, and adds specific functionality to appropriate component instances. E.g. a “Button” component consists of the functional attribute of a 2 state switch reflecting that a button can be pressed. This model is used to connect recommendations with components especially in the second phase, where the user input is component related.
3) Every output is defined as an instance in the Recommendation class. Each consists of the predicates Name, Text, Summary, Rules, Phases and an Attachment, where e.g. Sketch Phase Template Layers can be stored. In the component attribute the administrator of the ontology is possible to configure rule sets for the CAD phase, if a recommendation can

directly adjust specific parameters in the second phase of product development.

4) The Environment Model stores all data related to the environment. That includes physical conditions of the environment of the real world, objects and characteristics of the environment etc.
5) Typical Tasks, which can be performed using a product are defined in the Task Model class. This model is based on Hierarchical Task Analysis (HTA) providing an interface, where the designer can define actions of the user for the evaluation in the virtual environment.

The system architecture of the recommendation system (see [5], [6] and [7] for a more detailed review) is divided into a back end, where all data is stored, and a front end, including all client-specific features used to obtain recommendations.

IV. CAD Phase

In the CAD phase the designer works mainly with a CAD system to create the product design. All functionalities are integrated into a widely-used CAD environment (Siemens NX) as an additional plug-in providing support to:

1) Manually annotate specific components of a product by their functionality and type
2) Describe specific variables in the CAD system directly (e.g. what parameter defines the button height?)
3) Apply specific recommendations derived from the Virtual User Model including a component rule to annotated component parameters

These recommendation results, which could not be directly applied to the product's model, can be presented visually to the designer and provided in alternative formats where needed e.g. as textual report.

V. Evaluation Phase

The evaluation of a product design is realised by means of a virtual usage simulation. The simulation is performed in real-time and is visualised in a virtual 3d environment. This enables investigating a range of usability and accessibility questions. In these assessments, environmental aspects such as different lighting conditions and surrounding physical space provide an approximation to the real usage experience.
The evaluation system enables designers to test their 3d product prototype virtually by running a set of different task simulations for a selected user profile and environment. Properties and conditions of the 3d environment and of the virtual user as well as the tasks available for the respective product are coming from VICON's Virtual User Model provided by the Ontology server. While the simulation is running, the designer gets visual and textual feedback on the task progress and its interim success. Subsequent to a task simulation the system presents a report for the task including a binary answer for whether the product can be considered as usable under the given circumstances or not, as well as a differentiated performance assessment. The evaluation results can be stored and used for further iterations within the product design lifecycle.

VI. Conclusions and Summary

In this paper a model-based design approach was presented based upon the creation and implementation of a Virtual User Model. It is expected that this design approach is potentially capable of supporting the early product development stage (before developing costly physical prototypes) by providing component and design recommendations as well as virtual experience simulation for a proposed 3D design.
The next steps of the project, user studies including both sides - beneficiaries and designers - will be conducted to verify this approach and test the user acceptance. Plans and specified test cases were already specified[8] to cover multiple aspects of the application in a similar way to initial ethnographic studies[9].

References

[1] D. Woods, "Decomposing automation: Apparent simplicity, real complexity," *Automation and human performance: Theory and applications*, pp. 3–17, 1996.

[2] A. F. Newell and P. Gregor, "User sensitive inclusive design - in search of a new paradigm," in *Proceedings on the 2000 conference on Universal Usability*, ser. CUU '00. New York, NY, USA: ACM, 2000, pp. 39–44. [Online]. Available: http://doi.acm.org/10.1145/355460.355470

[3] C. Abbott, "tiresias. org information resource for people working in the field of visual disabilities," *Journal of Assistive Technologies*, vol. 1, no. 1, pp. 58–59, 2007.

[4] Vicon Consortium, "Deliverable 3.3 - second prototype of the virtual user modelling software framework," 2012.

[5] ——, "Deliverable 3.4 - final prototype of the virtual user modelling software framework," 2012.

[6] M. Modzelewski, M. Lawo, P. Kirisci, J. Connor, A. Fennell, Y. Mohamad, S. Matiouk, M. Valle-Klann, and H. Gökmen, "Creative design for inclusion using virtual user models," *Computers Helping People with Special Needs*, pp. 288–294, 2012.

[7] M. Lawo, P. Kirisci, M. Modzelewski, J. O'Connor, A. Fennell, T. Fiddian, H. Gökmen, M. Klann, M. Geissler, S. Matiouk, and Y. Mohamad, "Virtual user models – approach and first results of the vicon project." *eChallenges e-2011 Conference Proceedings*, 2011.

[8] Vicon Consortium, "Deliverable 4.5 - evaluation procedure handbook," 2012.

[9] Vicon Consortium, "Deliverable 1.1: End user and environment field study," 2010.