Empowering the User in Product Design with Virtual Reality

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Abstract

Positive empowerment of users through their simultaneous involvement in decision-making whilst a product is being created is a novel approach that has promising potentials. This involves the use of collaborative design combined with emerging interactive virtual environment technologies. The present paper illustrates a process model that addresses the development of an end-user involvement model. The objective of this paper is to describe a study that investigates the involvement of end-users in product design in order to improve the overall effectiveness of the process of designing, and aims to develop tools that allow collaborative interactive 3D designing capabilities for all stakeholders (i.e. end-users, professional designers, and product retail companies). An overview of the theoretical framework of the study will be presented in the hope to widen the debate as to the merit of such research and possible means to improve the research methodology.

1 Introduction

Industrial design (or product design) refers to the process of designing objects for human use, including the designing of products, packaging, furniture, appliances, transportation, clothing, and any other imaginable things used in daily life (Norman, 1988). The primary goal of industrial design is to produce products that satisfy the needs of the users; other important goals are ease of manufacturing, and acceptable aesthetics. Present industrial design practice typically includes users in the early stages to identify requirements, and then again, to evaluate prototypes of designs. Users are not involved in the actual design process itself. This lack of user involvement can lead to designs that do not quite satisfy the users' intended requirements (IDFORUM, 2001). This paper investigates a model that will enhance users' involvement in the design process in order to improve the overall effectiveness of industrial design. The aim is to develop a virtual computer-based system that enables users to customize and design products at an acceptable level, using three dimensional graphical interaction and interfaces.

The research aims include understanding and subsequently providing techniques, design solutions and tools to support the virtual collaborative activity of designing in a virtual interactive 3D environment for end-users, professional designers, and product retail

companies. This study will help ensure such software environment and tools address actual real user needs, and that the design & development process are being appropriately guided by these needs. It will also lead to an improved relationship between end-users/designers/manufactures/retail companies (Aurum, & Martin, 1999; Booth, et al., 2001). The main aim of this study is to allow end-users to participate actively from their homes or their work environment, either to design their own customized objects and order them, or to be involved in bigger design projects, such as public design projects, where they will contribute their daily life experience and their own creativity.

2 Background

In industrial design, a product that has been designed according to the needs of users is not guaranteed to end up corresponding to their real requirements. It all depends on 'how' people are represented in the design process. In addition to this, due to a lack of connection between design practice and design research, a substantial number of designers, in the UK, are making use of their colleagues and themselves to 'represent' end-users instead of using more representative sample spaces of users (Hasdogan, 1996). The premise is that, involving users in the design process assists in reaching better design solutions to existing or hidden design problems, and direct useful feedback. Furthermore, Balu, (2000) argues that users can create knowledge, if they are allowed to do so. The best product designs have been reported to occur when designers are involved in collecting and interpreting customer data (Holtzblatt, & Beyer, 1993). User-centered techniques involve either having the designer participating in the user's world, or the user participating in design activities. Both approaches are useful, as long as the user can be as effective as possible in both roles. The designer plays a key role in providing any material that might help and facilitate this transfer of experience. Traditional market research methods, through focus groups, interviews, and questionnaires, have been focusing more on what people say and think while being efficient and cost effective (Sanders, 1999). Information on what people do can be collected in real life context places where people live or work. This approach combines psychology and design, and focuses on what end-users make or can create, in an attempt to help designers to learn from end-users memories, current experiences and ideal experiences (Sanders, 2000).

The many advantages of end-users' direct involvement into the process of industrial design can be summarized as follows: users notice things that tool researchers don't (Pancake, 1997); users help "sell" the research. Users do get involved in the sense of making a real commitment to a research project. This is called "the spontaneous supporter phenomenon", developing spontaneously as users can follow the results of their ideas and criticism involved in later iterations of the design (Pancake, 1997). Furthermore, users can bring direct real feedback; they are experts related to their daily life and the objects around them; they bring in important personal daily life knowledge; they are excellent at reacting to suggested designs; and saying what is wrong with it. Ultimately, users can generate more ideas and points of views to be explored; the knowledge collected is otherwise inaccessible to designers and other stakeholders (Demirbilek, 1999).

Considering the previous advantages, we believe that the development of an interactive 3D collaborative design software based on an expert system, specialized towards letting end-users achieve professional results will be of great use in providing a direct and ongoing feedback on users' preferences, needs, and trends to companies (design consultancies or producing companies).

The stakeholders involved are as follows: the end-user – designers (product designer & software designer) –engineers (industrial & software) – manufacturers – and marketing people. The active participation of real people in the design process involves collaboration between these people and professional designers (Burdman, 1999). Furthermore, a de-specialization of many professions is foreseen (Jones, 1999). The industrial design profession has come a long way and is facing serious changes with the rapid advancement of technology and changing user demands. According to Sanders, the role of designers will change, allowing them to become more involved in creating the tools for the end-users to express their real needs and dreams. Psychology will be an important attribute and designers will be translators and interpreters of visual expressions created by end-users. Sanders (1999) adds that designers will use this translated and interpreted information as a source of inspiration in design.

3 Significance

Over the last several years there has been a huge growth in 3D CAD software oriented towards use by professional designers. With the onset of this growth, many product retail companies have paralleled this trend by investing in the creation of interactive Web interfaces, allowing their customer to customize their products, in a limited way. Virtual Reality is also an emergent technology, which has the capability of impacting the product design process. It is a high-end user interface that involves real-time simulation and interactions consisting of the usual auditory and tactile features. Thus, the user (or designer) feels submerged as if they were actually in the three dimensional space (Gatarski, & Pontecorvo, 1999; Kerttula, & Tokkonen, 2001).

Despite this rapid growth, there is often very little understanding of how this technology can be most effectively utilized to suit larger population samples and how it impacts on consumer behaviour and end-user feedback (Dahan, & Srinivasan, 1998). Commercial examples of such attempts can be found on web pages where end-users can customize, their "own" shoes online, for example, using a palette of different basic shoe types, different colors, textures and materials (Nike.com). Non-commercial sites demonstrate user customization with interactive small games (such as sodaplay.com, tcm.org). The development of these web sites is closely related to marketing strategies, allowing end-users to purchase their 'own' designs. All of these examples provide an indirect interactivity that does not allow for the benefits of real users inputs.

3.1 The Proposed Model: Virtual Collaborative Design (VCD) Model

The virtual collaborative design (VCD) model (see Figure 1) between end-user and designer has been adapted from a previous study (Demirbilek, 1999). This design model links end-user requirements and needs with various designing activities. In the VCD model, the contribution of end-users and designers to the various stages of the industrial product design process is explained schematically. There are 8 main stages and the intensity of the contribution is shown with thin and thicker lines (thicker lines denoting substantial contribution). The contribution discussed here is happening through online virtual collaboration. The 8 stages of the VCD Model are as follows:

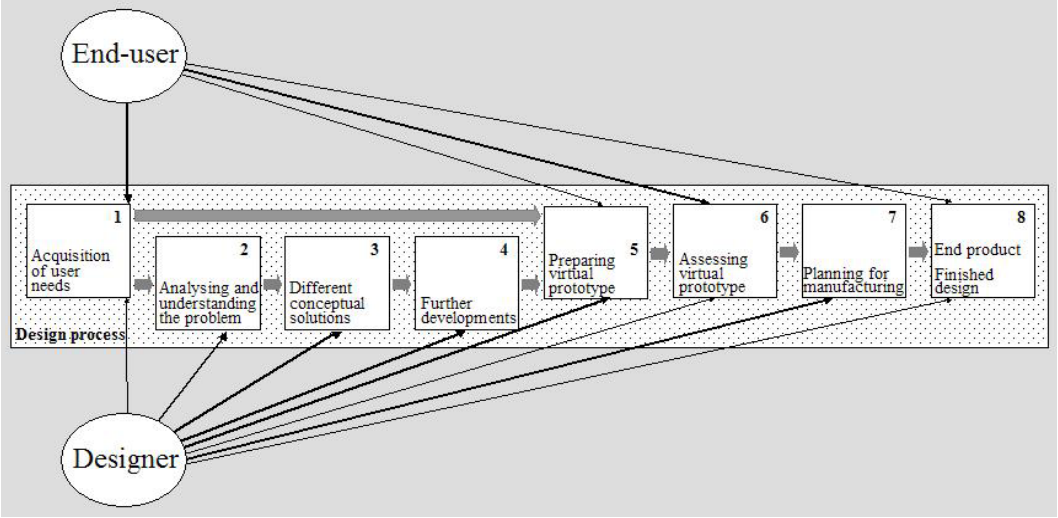

Figure 1. Virtual Collaborative Design (VCD) Model.

Stage 1 of the VCD model is the acquisition of user needs, related to the object to be designed – the input from end-users is substantial; stage 2 is the analysis of the problem(s) related to the object to be designed; stage 3 is the creation of different conceptual potential solutions; stage 4 involves further development where one of the concepts is developed further; stage 5 presents a virtual prototype of the designed object to be seen in three dimension on the screen – end-users can help here by giving feedback; stage 6 is the assessment of the previous 3D virtual prototype – end-users can again asses that stage and give feedback; stage 7 is the re-evaluation of all the previous stages and plans for the final manufacturing of the designed product; stage 8 is the final design. This model needs to be refined and validated using results from user and designer surveys and user usability testing experiments. This requires the development of an Interactive virtual 3D software system that will apply the VCD Model and allow non-professional end-users to be involved into "designing" products in a foolproof manner, as well as learn from the interaction. End-users will be able to simultaneously participate in stages 1 - 5 - 6 – 8 of the process,

3.2 Methodology

The research methodology combines hypothesis-based theory building with an empirical evaluation and refinement. Supporting all the above components will be a series of user/designer surveys and SUMI questionnaire, and usability testing experiments. Experiments will be conducted and the software system will be tested through extensive use of the Human Computer Interaction (HCI) labs. This will be followed by case studies involving furniture companies to test the model and the virtual software system, allowing end-users to be involved in the different stages of the furniture design process. The aim is to provide an environment where the consumer can determine and modify the foreseen functions on one product as well as deciding on the following: a) the form, b) dimensions and proportions, c) colors, d) materials and textures, e) finishes, and finally f) cost.

The foreseen key outcomes of the present study are as follow:

- An improved understanding (represented as a model) of the boundaries and limitations of end-users' involvement in the process of virtual collaborative product design.
- A documented and validated development process that addressed end-users' requirements and involvements in order to facilitate more cost-effective development of internet-enabled designing and purchasing systems. The process will support its rapid adoption by online furniture producing companies and related businesses.
- A set of intelligent decision support techniques that will support the task of designing by end-users.
- Development of software and a virtual toolkit that provides support to end-users, designers and manufacturers. This toolkit will facilitate a new kind of collaboration between users and producers. The tool will implement both the design process and the supporting techniques in managing and resolving user requirements and producers need for constant end user feedback.

4 Conclusion

The planed collaborative virtual 3D design environment will provide a benchmark and will have many development opportunities for commercial and educational purposes. Furthermore, it will improve the relationships between the stakeholders for the following reasons: a) user decisions will have direct impacts on the design of the end-product; b) users will be able to use their creativity to customize a product to their needs; and finally, c) improved communication will result between the end-users and other stakeholders, including designers, engineers and marketing people. This study will provide insights into the appropriate coupling of different levels of design with various aspects of end-user, designer and companies needs (e.g. business objectives, content requirements, functional and non-functional requirements). The development of the Virtual 3D design toolkit will benefit to consumers, as well as design education, design practitioners and manufacturers as it will open new directions for designing products, learning to design and buying products online. An effective development process will allow real users to interact in a direct manner, helping in the design process of the product, learning from it, and providing direct feedback to the involved companies. Successful companies or organizations will probably be the ones that can attract end-users to their web pages with user-friendly interface designs, and encourage them to participate in ongoing design projects with the help of carefully designed virtual toolkits. The study builds upon earlier research into user involvement in design (Demirbilek, 1999), and decision support (Aurum, et al., 2001; Aurum, & Martin, 1999; Booth et al., 2001). The non-professional user involvement in the design characterization model provides a requirements framework identifying the key elements that should be specified and designed, as well as linkages between these elements.

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