User-Centered Design of a Lamp Customization Tool

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ABSTRACT
Unique self-designed products are currently in great demand. The customization process of these products requires a good understanding of the customer's needs as well as tools that allow them to make the right choices. We provide a solution that enables users to design lamps that fit their needs and the interior design of their home. Our proposal is an Augmented Reality (AR) tablet application that allows customization in context. The solution was low- and high-fidelity prototyped in several iterations. Users enjoyed the customization process and expressed satisfaction that the app would enable them to create a lamp that is personalized and unique.

Author Keywords
Customization; Augmented reality; Rapid Prototyping.

ACM Classification Keywords
H.5.1 Augmented reality; H.5.2 User-centered design, Prototyping; J.6 Computer-aided design.

INTRODUCTION
Trends in product design and consumption are changing. Instead of mass-production, small-scale personal production processes are becoming highly valued [4, 8, 10]. Customers perceive the value of self-designed products as higher when these meet their preference system (*preference fit)* [3]. Given that, they are willing to pay more for them than for standard items [2, 9]. According to previous research [5], the most important parameters to be customized are lighting, beauty, purpose, and type of the lamp. Furthermore, different strategies are used [6, 7], some users know exactly what they want, while others need to look for inspiration before customizing. Since most users do not possess the skills necessary to visualize their designs, visualization support should be provided. However, the customization tools currently available for lamps are limited, and do not consider the context for the product. User requirements were translated into features and design specifications for a customization tool. As a result, the design of a customization tablet application (app) that ensures the user's preference fit is presented.

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DESIGN
Our app allows users to place the lamp in context. To this aim, it includes an Augmented Reality (AR) plugin to show a 3D model of the customized lamp in the room where it will be placed. To start the customization, users should choose a lamp type and place it in context by using the AR plugin with air gestures. The different gestures provide different mental models, which helps to avoid confusion between placement of the lamp in space (air gestures) and changing the size of the lamp (pinching). All other interactions are standard touch screen interactions. After choosing a lamp type and context, users can explore pre-designed lamps or start from scratch with their own design. Before a lamp is ready to be ordered, they need to specify the values of several attributes. These attributes are shape, size, material, colour, and light settings. The realism of the lamp-representation increases as more attributes are customized, from a wire-framed to a 3D-rendered model. The options to customize each attribute are shown around the lamp (figure 1). To support the decision making process, the system offers tips for each choice. Users can always switch from a Static- to Live-view. The Live-view provides real time visualization of the lamp in AR, allowing the user to see different lamp perspectives. The Static-view shows a picture representing one particular view of the room as a background for the lamp customization. Its advantage is that the users do not have to constantly hold the tablet at face level.

Figure 1: Light-settings selection screen.

EVALUATION
The design was created following a user-centered design (UCD) approach. The UCD process was applied iteratively, with prototypes of different fidelities. First, a paper prototype was used to test, in four iterations, the lamp customization process, the general layout of the system, the

understandability of icons, and the main interactions. After each iteration, the tool was adjusted according to the results. Second, a hi-fi prototype was used to test the improved layout, interactions and final visual design. A video prototype of the final concept was created.

Methods

Participants. Ten participants took part in the low-fi evaluation (average age=26.7, SD=2.58). Two of them had design experience; five participated in the first, two in the second, two in the third, and one in the last iteration. Six participants, with no design experience, participated in the hi-fi prototype evaluation (average age=27.17, SD=2.23).

Procedure. Participants were guided through a scenario in which they had to customize a lamp. Afterwards, an interview was conducted. Additionally, in the hi-fi evaluation, participants received a box with the real lamp prototype, and filled in a questionnaire. It included the System Usability Scale (SUS) [1] and three additional questions to assess the enjoyment of the process and their self-perceived ability to customize a lamp that fit their needs and home.

Implementation. All low-fi interface elements were prototyped using cardboard and transparent films to simulate a tablet. From the second iteration, paper elements were overlapped on a tablet to give users the sensation of weight. Furthermore, the camera of the tablet was used to simulate AR. While the camera was on, the experimenter would move a printout of the lamp behind the screen to respond to the user's air gestures. For the hi-fi prototype, Proto.io was used to simulate a native Android tablet app, including touch screen gestures. A Samsung Galaxy Tab3 10.1'' with Dolphin browser in full screen mode was used. The Augment app was used for the Live-view. A tracker was moved by a person to match the gestures of the participant to simulate air gestures. The basic and finished lamp models were created in Blender 2.69 and Solidworks, respectively. The change between the live and static view was performed manually.

Results

Several main difficulties were observed. First, users had troubles understanding air gestures despite several types of instructions that were provided. Still, in the hi-fi evaluation none of the participants used air gestures to position the lamp. Four of them used known tablet gestures instead. Second, two participants tried to draw the lamp shape. This was not supported by the app. Finally, in the hi-fi evaluation, one participant mentioned that it is very good that the light effect is shown, but the visualization should be more realistic. However, all the participants valued the idea of customizing a lamp in context. They felt that the system would allow them to customize a unique lamp that cannot be found in a store. After unpacking the physical lamp, four participants mentioned that the lamp looked the same as the visualization in the app. Additionally, the interface was perceived as intuitive, simple, with a good flow. The arrangement of the levels of the attributes around the lamp was liked, and having Live- and Static-views was highly valued. The average SUS score was M=83.75 (SD=8.91). All participants enjoyed the customization (M=4.67, SD=0.52), and they believed that this system would help them create lamps that fit their home (M=4.67, SD=0.52) and their needs (M=4.5, SD=0.52). The maximum value of the scale is 5.

CONCLUSION

The designed app successfully guided the users through the customization process, provided inspiration for novice users and facilitated the decision making process. Despite testing with fixed scenarios, a method to test preference fit indirectly was devised. Participants indicated that the real lamp was quite similar to the app's representation. Furthermore, a quick AR prototyping tool was developed, using the Wizard-of-Oz technique, and proposed the basis for the use of air gestures to place objects in AR. Future work should explore the influence of feedback on air gesture learning and that of different light representation fidelities on preference fit.

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