CptS 543 Assignment #1

Applying the Norman 1986 User-Centered Model to Post-WIMP UIs:

Theoretical Predictions and Empirical Outcomes

Oluwafemi Ajeigbe

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*Summary:* The focus of this article describes the impact of the post-WIMP UI experience in terms of improvements in a user's mental representation of a user interface or a task, using Norman's 1986 model. Primarily, the authors of this article applied the seven stages of the Norman model of interaction to post-WIMP UIs to provide theoretical explanations as to why the post-WIMP UIs perform better than the WIMP UIs. In their study, the authors stated that users build mental models of UI while interacting with it. Based on Norman's model, an enhanced UI/task mental representation will close the gap between execution and evaluation.

The main contribution of this paper to the literature is to show the different ways the Norman model is explained in the improvements in post-WIMP UIs. The authors used the interactive Cube Comparison Task (CCT) to determine if UI conditions impacted users' mental representation of UI and task. The authors found that touchscreen and tangible UIs produced a richer mental representation of UI and task than the mouse, supporting their first hypotheses. The authors also found that users of the post-WIMP UI had enriched mental representations compared to the WIMP UI. However, there was no statistical backing for their third hypothesis as the mental representation of the high SA individuals was not richer than the low SA participants. The authors concluded that understanding more about the cognitive structures involved in UI interactions, as posited by Norman, is essential to understanding post-WIMP UIs and their underlying cognitive processes.

*Critical review:* This paper has seven listed authors: G. Michael Poor, Samuel D. Jaffee, Laura Marie Leventhal, Jordan Ringenberg, Dale S. Klopfer, Guy Zimmerman, and Brandi A. Klein. Poor is an Associate Professor in the Computer Science Department of Baylor University and focuses on Human-Computer Interaction (HCI) and Accessibility. Four of the seven listed authors are from Computer Science backgrounds, while the other three are from Psychology backgrounds. Jaffee, Leventhal, Klopfer, and Zimmerman are all from Bowling Green State University. Jaffee and Klopfer, both from the Department of Psychology. While Leventhal and Zimmerman are from Computer Science. Ringenberg is a Computer Science professor at the University of Findlay. Klein is presently an Assistant Professor of Psychology at Franklin Pierce University. At the time of writing this article, her affiliation was the Missouri University of Science and Technology.

All the authors appear to have a well-grounded and extensive background in Human-Computer Interaction. It seems that these authors have written a couple of articles for more than 15 years. The citations in their report draw on excellent past research, which showed the authors' strengths. One of which was how they were able to explain, in detail, the different principles and theories applied throughout the study, and being able to use the two significant theories of interest (Norman principles, Reality-Based Interaction) to explain the practical design applications to the WIMP and post-WIMP UIs.

One weakness I found in this study is the number of participants in each condition. The authors used sixty-seven participants for the study. It is essential to have a substantial sample size from past studies on sample sizes. Our sample dictates the amount of information we have and, therefore, determines the precision or level of confidence that we have in our sample estimates. The authors of this article used about 8 participants per group, which was small.

Another weakness I observed in this study was that the research was purely theoretical, and this is a significant weakness as HCI should be tied to practical HCI designs. The metrics used in this article to examine the relationships between the Norman model and the post-WIMP UIs were limited to just two (the multi-sensory inputs and the engagement of the RBI knowledge). It was argued in the paper that a user's reflection and planning in terms of UI interaction might be another metric to measure the relationship mentioned earlier.

*Integration with Related Work.* One of the main works developed in this research was using the CCT to measure a users' mental representation of a task. Just and Carpenter [1985] used non-interactive, static objects to measure the difference in users' mental representations. They treated the CCT as a problem-solving task. The study by Poor, G.M. *et al.* [2016], in contrast, used the interactive versions of the CCT to measure both users' mental representations of U.I. and tasks and users' problem-solving strategies. Another past work that was a big part of this study was established on the Reality-Based-Interaction model posited by Jacob et al. (2008). The authors based their argument on this framework of emerging U.I. interaction styles. Jacob et al.'s study outlined four RBI pieces. However, Poor, G.M. *et al.* only applied three to their research.

According to Google Scholar, seven articles have cited this work, all centered around user-computer interaction. Girouard et al. [2019] cited Jacob et al. [2008] and this current study by Poor, G.M. et al. [2016] to research the impact of the RBI framework both on contemporary research, through content-based citation analysis, and in HCI education. This study was designed to evaluate the implications of the RBI framework in terms of its uses and evolution. Findings from the research supported the claim that the RBI framework used in the post-WIMP U.I.s study is still very relevant in user interactions. Another related research where this current study was cited was Samuel, D.F. et al.'s [2018] research on interactive 3D objects, projections, and touchscreens. The study looked at two of the features of objects in a user interface that could impact aspects of a user's experience. They focused on 3D object projection and interactivity. It was reported that the manipulation of interactive 3D objects on a user interface could affect interactive problem-solving. As such, a designer should not simply go with a design that looks normal. Instead, a designer should assess the U.I.'s interactivity and task combinations, recognizing that all might impact perception and problem-solving.

*Implications for HCI.* This study poses the question of standardized interaction methods. Many UX/UI designers have followed the standard design principles for a while now. (e.g., menus, buttons, etc.). Should this be encouraged more? Or should each UI/UX designer be allowed to develop their designs as inspired? As Norman's design model described, a standardized format offers an easier gulf of execution where the user can transfer previous knowledge of an old U.I. to a new U.I. Nonetheless, for future HCI work, should this restrict the overall creativity of a U.I. designer?

Researchers in the field of Human-Computer Interaction can apply the theory developed in this study to a broader range of tasks. In this research, a specific task aimed to exploit how users build their mental representation and spatial abilities. Could another task be selected to test the effect of post-WIMP UIs on the mental representations of users? Would this be better? Another significance mentioned in the paper is how the user's mental representation was measured, tricky. Whether or not measures operationalized Norman's gulfs on a UI or task was a topic of discussion amongst the authors. Could this be improved?

Another HCI implication is how the authors used the Norman design principles to examine how users interact with U.I.s and perceive things. Many U.I. designers have used the Norman design principles, and past studies have shown how important it is to follow them in U.I. designs. An implication for technology users is that many software applications developed today still depend on users' perception of U.I. interfaces to build mental representations of the U.I. based on how they interact with everyday objects. The authors of this current study proposed that it is pivotal for every designer to follow to the letter these design principles. In addition, another HCI implication for subsequent research is the opportunity the study offers to researchers. Research can further investigate the proliferation of post-WIMP U.I.s. Past works solely focused on the interplay between U.Is and a user's mental representation of the U.I. [Hutchins et al. 1986]. Although the current study explored the impact a U.I has on mental representation, there is still a lot of work that can be done to study the implementation of the relationship between some of the elements (RBI, CCT, IIM etc.) used in this study while creating evaluation metrics that will further improve Norman's design model.

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