Conceptual Multi-Device Design on the Transition between e-learning and m-learning

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Abstract

This paper clarifies theoretical assumptions about the Conceptual Multi-Device Design and presents a practical implementation for e-learning applications. Interfaces are generated automatically for handhelds (smartphone, Pocket PC, etc.) maintaining the desktop look and feel with the same actions flow for a given task. First prototypes were better evaluated than a successful commercial approach. Usability evaluations will be conducted to investigate the advantages of this proposal for the distance learning.

1. Introduction

Since the stenographic postal cards exchanged between English students in the middle of 19^{th} century, Distance Learning has received many technological contributions, especially in the last decades with the Internet advent and its e-learning environments, like the Tidia-Ae (tidia-ae.incubadora.fapesp.br), TelEduc (teleduc.nied.unicamp.br), Moodle (moodle.org) and Sakai (sakaiproject.org). However, by designing these systems for the mobile learner, in some extent, we took a step backwards by moving from the paper-based to the online learning, since students were required to study at a place (and a time) where a computer with Internet access was available. The commercial industry presented many mobile solutions (Pocket PCs, smartphones, etc.) that will certainly open up several opportunities for research and new developments on collaborative learning. This should be the focus of educators moving from e-learning to m-learning (mobile learning through portable electronic devices), aiming to extend and increase the flexibility offered by web systems in the mobile field.

Therefore, a new challenge appeared in the Human-Computer Interaction field: to develop multi-device interfaces for existent applications. Some have tried device oriented designs with linear transformations, creating mobile interfaces from scratch, like Avantgo (www.avantgo.com) and Usable Net (www.usablenet.com); others looked for dynamic and automatic adaptations, but still focusing on the device [2], [4], [5]. These and other related approaches were well received by many mobile users who could finally access applications on their handhelds with better usability. However, the new interfaces generated are usually different from the original and lack in usability when users need to change from one interface to another (e.g. from a desktop PC to a smartphone), especially when researching and/or comparing information [6], [7].

These observations led to the Conceptual Multi-Device Design (CMDD) proposal [9], which maintains the application's conceptual model on the generated interfaces to avoid ambiguities on the user's mental model while interacting with them.

This paper clarifies theoretical assumptions about the CMDD with an implementation for the e-learning domain. First prototypes were constructed to smooth the transition between e-learning and m-learning and some informal results point to the acceptance of this proposal. Formal user evaluations will be conducted sooner to check these first impressions.

2. Revisiting and Clarifying Some Issues on the Conceptual Multi-Device Design

The CMDD hypothesis states that one application doesn't need as many conceptual models as the final media devices to achieve its maximum usability. By conceptual model, we mean the *description of the proposed system in terms of a set of integrated ideas and concepts about what it should do, behave and look like, that will be understandable by the users in the manner intended* [11]. From the definition, it is clear that conceptual model isn't just class diagrams with attributes and relationships [1], [12], but also the interface's behavior (navigational model) and appearance (presentation model). In other words, the proposal assumption is that *n* interfaces designed for an application accessed through *n* devices should enable users to perform tasks in the same way, including the action and perception of them.

Affirming that CMDD suggests not changing the conceptual model between the application interfaces means that the user's model for this application should always be the same. It doesn't matter if he/she wants to check an account balance through an ATM machine, a tablet PC or a phone. The task should be performed following the same action flow, despite being words typed, written or said. Humans have good adaptation abilities, but adapting to individual task procedures for each device will probably lead to misunderstandings. Different conceptual models demand individual maintenance that generates new inconsistencies to which the user will have to readapt. Hence, it doesn't matter how good people are to adapt their mental model; each maintenance improvement will cause new frustrations, uncertainties and distrusts when interfaces are accessed alternatively.

It's interesting to note that this approach won't take the best of each device, like designing brand new interfaces for each one, but turns the application multi-device access into an important concept for Interaction Design. Considering the example of browsing web pages on a desktop PC and on a smartphone, the hypothesis is that if none of the mobile users would ever had to browse the web on a desktop and nor the desktop users would browse on a handheld, there would be no problem on changing the application conceptual model. But if any of these users have to access the system through more than one of its interfaces, than CMDD might point to a better design proposal. Figure 1 adapts Norman's framework [8] to illustrate how this approach suggests design on a multi-device context.

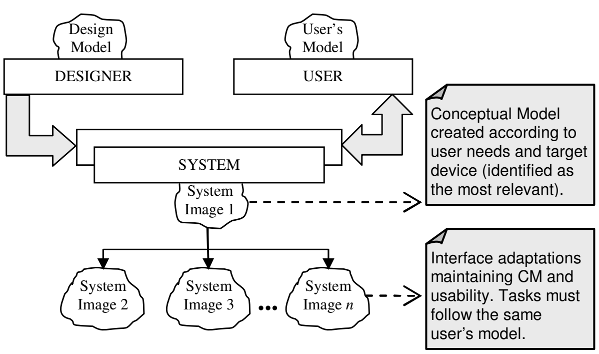

Figure 1 - Interactive components from Norman [8] adapted for CMDD. Changing the conceptual model would result in *n* models for each component.

3. Towards an Empirical Validation

Some e-learning prototypes were implemented using CMDD [10]. Currently, the interface adaptation doesn't require additional internet traffic and takes less than two seconds to adapt a web page using the browser script interpreter. The hardware used was the HP iPAQ Pocket PC h2400 running Windows Mobile 2003 but could be any other handheld with a CSS, DHTML and JavaScript compatible browser.

According to Oliveira & Rocha [10], the Summary Thumbnail project [6] uses automatic transformation to desktop web interfaces obtaining results very close to the CMDD proposal, but still has some issues to be considered: a better summarization process and a smoother transition between thumbnail and detailed views. With the first prototype generation, our main focus was to provide a faster detailed view over the thumbnail using the focus-plus-context technique to prevent localization loss with frequent zoom-in and zoom-out. The hint concept, present on almost every graphical user interface, was used to display full texts and normal sized images whenever the user points to an object on the page. This approach also removes the interaction fear of pointing to something and guessing if zoom-in or link navigation will be performed. Also, the user may choose the full text to stay on page or continue hidden. Figure 2a presents this prototype to access a course in the TelEduc e-learning environment.

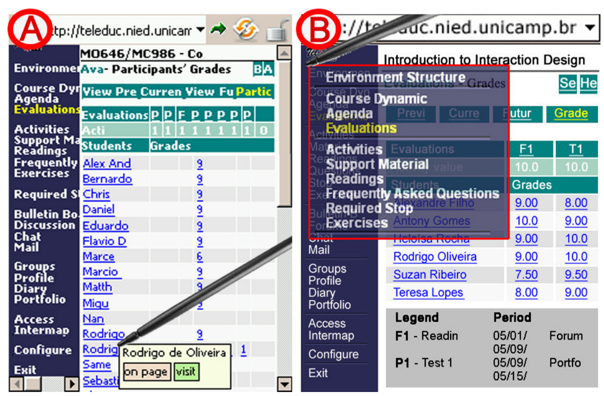

Figure 2 – Prototypes detailed view: (a) First generation: interface is shrunk, texts are summarized (right-to-left cropping) and fonts are increased. When the user points to summarized text, detailed view appears over the thumbnail without loosing context (full text can be shown on the thumbnail using the *on page* button and this information is stored for future accesses). If the user points to any link, an additional button is provided on the detailed view to visit it. (b) Second generation: TF/IDF [3] and stem dictionaries are used for better summarization. The detailed view uses focus-plus-context with a low opacity level to improve context view.

Although the detailed view presented on Figure 2a preserves layout without strong transitions between the thumbnail and detailed views, it loses format attributes useful on systems more iconic than TelEduc. To solve this problem, it was used a mix of the Direct Migration (no transformation applied to the page) and the hint feature. Figure 2b presents this approach used on the second prototype generation.

Recently, the first prototype was informally tested on a few institutions, like University of Campinas (www.unicamp.br), CPqD (www.cpqd.com.br/usa/) and a workshop demonstration for the Tidia-Ae project. These informal evaluations revealed some good impressions, indicating a clear preference over the awarded commercial solution by Opera (www.opera.com/products/mobile/reviews). Figure 3 compares screens generated by both approaches.

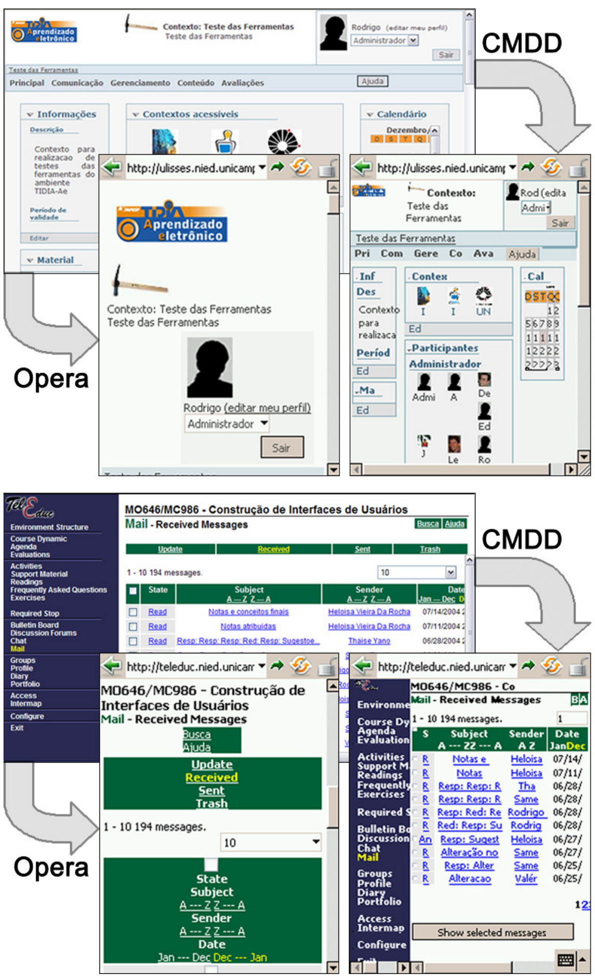

Figure 3 - Comparison between interfaces generated by the prototype and the Opera *Fit to Screen*. Informal evaluations revealed a clear preference for the CMDD.

4. Conclusions

The Conceptual Multi-Device Design [9] proposal was revisited to clarify issues about the user's mental model and the proposal's assumptions. It was also tested in practice for the e-learning domain with favorable impressions. Next prototypes benefit iconic systems with the Direct Migration approach inside the hint detailed view to prevent context loss. User evaluations will be taken sooner to investigate the advantages of CMDD for e-learning environments.

5. References

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