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User Experiences with the XO Laptop by US School Children and HCI Experts

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Abstract

We examine the user experience of the XO laptop (the "$100 laptop"). The XO laptop combines many technology innovations, and is used in the US and abroad. Having users perform a range of simple tasks, we demonstrate that several aspects of the XO laptop and other similar devices can be improved, including hardware and software. Our recommendations are not difficult modifications. What we found suggests that usability is a risk to the success of this device, but usability was not seen as such in this case. We hope to see the usability of the XO laptop become more polished, and that usability, in general, is considered appropriately as a risk.

Keywords: usability studies, XO Laptop, hundred dollar laptop, risk-driven spiral model

A Laptop Designed for Every Child

In January 2005 Nicolas Negroponte, co-founder and director of the MIT Media Lab, initiated the project "One Laptop per Child" (OLPC, wiki.laptop.org/go/The_OLPC_Wiki) to design a low-cost laptop

for children, which some called the "hundred dollar laptop" because of the target price. The OLPC project received widespread press coverage and praise for its commitment to improving children's learning—especially for children in the developing world. Several industrial hardware leaders joined the project and became sponsors. Government officials in many countries, including Argentina Brazil, the United States, and Uruguay have expressed great interest in the project. Others call it the XO laptop or the XO PC because of the project's logo. We call it the XO laptop because the price may change.

The goals of the XO laptop hardware design were that it: (a) be affordable, (b) be rugged and resistant to moisture and dust for children to use in different environments, and (c) consume low power in places where power outages are frequent. Usability was not prominent in these early goals. The first batch of the XO laptops was released in December 2007 (one of these is shown in Figure 1) and received good reviews with regard to its innovative hardware design. However, the near term and long term future of the XO laptop remains uncertain for the lack of empirical data in the field and other potential social and cultural concerns (Perry, 2007).

In a recent report, Pew and Mavor (2007) present a theory of how to address risk in large system design (which the XO laptop, its users, and their educational systems are), by more explicitly including usability-risks in the spiral development model (Boehm & Hansen, 2001). Pew and Mavor argue that usability is a risk to the success of projects, and that this risk must both be judged and also compared to

other risks (such as cost, manufacturability). Under the guidelines of this model, the software design processes are divided into several phases in which an understanding of risks is used to determine project development. In other words, risk management can be seen as a driver to the success of large systems.

In this paper, we explore the usability of the XO Laptop as a potential risk to the success of the OLPC project. If usability is not tested and managed, the success of the project might be affected, as has been the case with other new technology projects. In this case, the risk arises because children interact with technology in different ways than the adults who designed it (Bruckman & Bandlow, 2007), and potentially in ways that the designers could not predict.

There is little published data describing children's usage of portable laptops, and the designers and users are rather different for this product. When little is known, simple usability studies will help find previously unseen risks (Clarke, 2006). The results of our study suggest that these target users appear not to have been the focus of the design decisions, and it provides ways the XO laptop can be improved (and the risks decreased) with several inexpensive interventions.

Examining Procedures

Data gathered from school children using the XO Laptop were the primary data for this study. We also included HCI experts' heuristic evaluations. Certain long term issues, which are harder to identify without longitudinal studies, can potentially be predicted by HCI experts without awaiting these long-term

research results. . Because the XO laptop is designed for children, we observed and interviewed school children using the XO laptop. Collecting data from two seemingly different groups, children and HCI experts, gives us a broader perspective and a wider range of data on possible problem areas of the XO laptop, particularly for its use in the United States. Three elementary school children and five HCI experts—participated in our study. The children were one 3rd, one 4th, and one 5th grader, and the HCI experts were four graduate students who have taken HCI graduate level courses majoring in industrial engineering, information sciences, and communication, and one professor who teaches HCI and related graduate level courses. The HCI experts used computers daily, and the children used computers at least twice a week. These results provide one perspective. However we should caution that the experiences of our users may be different from those who have never used personal computers before.

Both the HCI experts and elementary school children were asked to perform the same set of three tasks on an XO Laptop – create a document, paint a picture, and record a photo/video/audio – in a series of three separate sessions, with one task per session. The XO laptop used was from the first release batch in December 2007 and did not contain any updates or modifications. Sessions were at least one day apart. These tasks were isolated from each other so there was no data exchange between activities. Each of the tasks examined the design of a specific activity and the general system navigation of the XO laptop. We analyzed the following general system navigation skills: opening and closing an activity; saving, retrieving, and deleting a document; and powering the laptop on and off. We also analyzed activity-specific skills

including typing using the keyboard, drawing using the touchpad, and using the built-in microphone and video camera. We told the participants that if they became uncomfortable or frustrated with a task, or could not otherwise complete it, they had the option of asking the experimenter for assistance to finish the session.

After each session we interviewed the participants, focusing on their experience with the XO laptop. The intent of this post-session interview was to establish where the participants believed the laptop could be improved, and to have the participants expound on their feelings in these areas. We encouraged the participants to give a retrospective opinion of the laptop that we could then compare to the verbalizations participants made during the tasks and the problems they encountered or mistakes they made. The questions to the HCI experts were slightly different, because the HCI experts should be able to deliver a more focused opinion.

Some Roadblocks

We asked both groups of participants to provide concurrent verbal reports while they were using the XO laptop. We observed that all of the children were able to verbalize their actions and feelings without trouble. Using "talk-aloud" verbal protocol analysis and interview data, we were able to qualitatively identify problem areas that our participants experienced. Some problem areas are related to hardware

design and others are related to software or interface design. The following is a list of problem area categories we have derived from the transcribed data analysis:

Problems related to hardware design

I. *Opening the XO laptop*: the data indicate that opening the XO laptop for the first time is a difficult task. None of the participants could open it in under one minute and only three out of eight participants could open it without help. The antennas on the laptop also serve as locks – down is locked, and up is unlocked. We observed several instances of participants flipping the antennas up (shown in Figure 2), and flipping them back down, locking the laptop again. As some participants mentioned in the interviews, opening the XO laptop is definitely not easy, although this is a "one time struggle"—once you learn it, you know how to do it.

By the second session, inability to open the laptop was almost nonexistent. This may mean that some type of temporary or renewable solution such as a sticker may be appropriate.

II. *Keyboard*: All of the HCI experts indicated that the keyboard (shown in Figure 2) is small for adults but may be acceptable for children's smaller hands. All of the children in the study expressed that they found the keyboard to be unusual.. One child mentioned that he wished the keyboard had the same feel and touch as a PC.

Although HCI experts were not certain if the keyboard design is suitable for children, none of our child participants liked it. We attribute this to negative knowledge transfer from PC or Mac usage. In general, the HCI experts did not like the keyboard, stating that in addition to it being too small, it had a "mushy" feel, often noting that it was probably designed for children. Not all HCI experts disliked the keyboard. One participant with an industrial engineering background remarked that the soft keys would suit children's fingers well, and suggested that their softness may help to prevent Cumulative Trauma Disorders (CTDs).

III. *Touchpad*: One problem we noticed when participants used the touchpad (shown in Figure 2) is that they often moved their fingers out of the touchpad area into the adjacent stylus area unconsciously and wondered what was wrong when the cursor stopped moving. Because there are no tactile cues to distinguish between the two areas, there is no way to tell these two areas apart without looking down from the screen. .

Problems related to software/interface design

I. *XO laptop Shutdown/Reboot tool:* While powering on was trivial for all of our participants, as some of them noted, you "simply press the universal power button", the proper powering off process proved to be challenging for nearly half of the participants. The software power off, shutdown, and reboot mechanism appears when the cursor stops at the center of the screen and a menu shows up for reboot

and power off (shown in Figure 2). Every participant thought it was "something like the desktop" or "wallpaper" and didn't think of it as a button. Although this is another example of negative knowledge transfer from PCs or Macs, generally designers do not use such large buttons. Participants started by searching for small icons, and six of the eight participants did not find the shutdown/reboot tool without help.

II. *Border menu*: The major problem with the menu that appears around the border of the screen (shown in Figure 3) was it often appeared when the participants did not want it. When it appeared it overlapped with the actual button they wanted to click, such as the stop button. Their typical reaction to the unexpected appearance was sighing, moving the mouse cursor to the center of the screen, and waiting for the menu to disappear.

File System simplicity: An "activity" on the XO laptop is the equivalent of an application on other computers. When an XO laptop user "keeps" a file, this is the functional equivalent of saving the activity. However, when the user activates the "keep" function, in addition to missing feedback from the action, there are no options as to how or where the file is saved. The files are accessed from the "Journal," a center for activity logs (shown in Figure 4). The files are also searchable—but some HCI experts were concerned that the lack of filing ability would prove a disadvantage, especially if children had to use the same XO laptop for an extended period of time.

One noted:

> I felt the need for folders, but I don't think the children would. Or, they might—because if they're going to use it for a period of two to three years, it's difficult to keep track of how and what name you saved a file

We then asked: "if the journal provided a search by date, etc., would that be enough to manage files without a folder filing system?" The response was:

> No, I don't think so, because you might not remember the date anyhow.

These responses and others lead us to believe that the file system of the XO laptop may be confusing or not intuitive to users, and some type of extension or folder system may be more appropriate. Another study on the XO also mentioned that the file system was on the top three things that the children disliked, even when they did not have prior PC or Mac experience (Hourcade, Beitler, Cormenzana, & Flores, 2008).

III. *Inconsistency of the feedback system:* The feedback system in the XO laptop is either missing or inconsistent. For example, when a button is inactive its appearance does not give users a visual status cue, such as being grayed out, to indicate its current status. We observed instances in which participants tried to insert a new row in a document by clicking on the "Insert a row" icon. Nothing happened when the mouse cursor was misplaced in the document—the cursor must be in the row

where the new row will be added. They were uncertain whether they clicked it or not and, as a result, clicked several times because nothing changed. Eventually, they realized that it did not work in that particular situation. Another obvious discrepancy between the user's expectation and the system feedback is the "Keep" function. Every activity has a "Keep" under an "Activity" tab to store the current activity in the journal for future retrieval. When "Keep" is clicked, there is nothing that visually indicates to the user whether the activity has been saved or not. One HCI expert remarked:

> If an adult can't figure out what it's doing, I wonder if a child can. And I don't think that that has anything to do with our previous experience or anything.

This problem was compounded by the fact that when the mouse hovered over the icons, a tool menu would appear, as with a PC or Mac. Most participants would then try to click the wording below the icon, which produced no result except for closing the menu. Although some drop-down menus support clicking on text options, such as the shutdown/reboot menu, the text under "Keep" is partially active and partially inactive—the user can select the text output type, which does not save the activity, and there is also a line that simply says "Keep." If this word is clicked, the menu closes and the activity would not be saved. When this happened, we asked the participant if their activity was saved, and the answer was universally "I don't know." We believe that this result arises from the lack of feedback. The same issue was also present in the

XO laptop's boot process—lack of information as the machine started up had several participants wondering if they correctly turned the machine on.

Findings and Recommendations

The XO laptop is an exciting technology for encouraging exploration and collaboration among children. The interactions between our participants and the XO laptop have demonstrated empirically that many usability problems exist within the design of the hardware, the software, and the operating system interfaces for users who have PC or Mac experience. We summarize our experience with the XO laptop in Table 2 for instructors, teachers, and parents who want to adopt the XO laptop. We hope that the information in this table will provide a shortcut to a more pleasant experience.

The XO laptop lacks physical documentation accompanying the product. Further, the XO laptop itself does not have obvious help functionality included in the operating interface, and so initial assistance is limited. The OLPC project does have a wiki available on the Internet for support and help, but because the Internet is not always available in many locations, and because users who need assistance with the XO laptop may not be able to access the Internet, this source of support may not be enough to help all XO laptop users. The results of this and similar empirical studies can identify design issues of the XO laptop and can serve as a source of information for a wiki and as an initial source of information if a physical operation manual is ever developed.

Although these design flaws hinder the usability and create frustration when interacting with the XO laptop, at least at the beginning, many of the problems would be easy to fix through redesign and by end users without increasing the cost. These appear to be areas for improvement, not fatal flaws. Flores and Hourcade (2009) observed and described their positive experience with the XO laptop in Uruguay. They too noted there are ways to improve both the hardware and the software. Because several school districts in the United States have already purchased XO laptops, these usability issues could be an obstacle for ICT (Information and Communication Technologies) integration in those locations. These results, while not devastating, are not encouraging. This design does not appear to have considered the types of users or the tasks they would complete and to have ignored usability risks. A recent National Academics report on reducing usability related risks in system design (Pew & Mavor, 2007) provides a framework for understanding this: most certainly usability was seen as a lower risk in this project than hardware price. However, these results suggest that the risk of failure or decreased use due to usability problems is greater than the designers imagined. We hope that the OLPC project and users can learn from this report and improve the usability of the XO laptop accordingly, and that similar manufacturers see how small investments in usability can reduce risks to product success.

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Figure 1. A child working with the XO Laptop.

Figure 2. A picture of the XO laptop with captions of different parts. A ruler at the bottom provides scale.

Figure 3. A screen shot showing the border menu when the mouse cursor is moved to either corner.

Figure 4. A screen shot illustrates a list of activities in the Journal document editor in the XO Laptop.

Table 1. A description of the tasks given to the participants, and the skills required.

Task	Description	Skill Required
Create a document	Use Write Activity to create a table with headings: state name, capital name, and population to describe three different states. Information is provided in the instructions. Save and find the document after the Write Activity is closed.	This task requires mainly typing skills, for both letters and numbers. It also requires menu selection to create a table, and minimal use of the touchpad when changing the cursor location is necessary.
Paint a picture	Use the Paint Activity to draw an animal face including eyes, ears, and mouth. Use different colors for face, ears, and eyes. Save and find the drawing after the Paint Activity is closed.	This task requires mainly touchpad operations for drawing. It also includes selecting and applying colors to different areas.
Record a video and play it back	Use Record Activity to record a one-minute video. Use Save and Use playback function to play the recorded video.	This task let the participants to explore the multimedia functions of the XO laptop.

Table 2. Observed difficulties for each population.

Area of Difficulty	**Children**	**HCI Experts**
Opening the XO Laptop	X	X
Finding the shutdown button and turning off the XO laptop	X	X
Finding saved activities	X	X
Confirming that activities are saved	X	X
Bringing up border menu only when needed; border menu popped up from time to time because the mouse cursor was moved to corners by accident	X	
Keys are not very responsive	X	
Keyboard feels "different" and small; Most did acknowledge it was designed for children		X
Staying within the touchpad area		X

Table 3. Summary of suggestions for adopting the XO laptop.

Potential Issue	Recommendation
Basic operation of the XO laptop	Children should be taught should be taught about opening the laptop, power on/off the laptop, and view mode keys.
XO laptop user interface	Children should be taught how to navigate in the Sugar environment, especially to show/hide the border menu, and the meaning of icons on the desktop. (Sugar is the desktop environment of the XO Laptop.)
Touchpad	Use a narrow sticker to differentiate the touchpad area and styluspad area.
File and feedback system	Children should learn a procedure to ensure their work is kept in the XO laptop without a problem.