

# Challenges in sustainability: Understanding users' appropriation and maintenance work of computational artifacts

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## ABSTRACT

Computational artifacts in today's computing environment emerge and disappear at a rapid pace. Due to the short life span of computational artifacts, we face challenges at the environmental scale such as increases in waste from old unused computers. Users also face with challenges in maintaining everyday computational resources that become continually outdated. In this workshop, we would like to discuss a group of users who have been independently appropriating and maintaining a DOS based discontinued palmtop called HP200LX (LX) for nearly ten years. From studying these users, we have identified several types of work that are involved in appropriating and maintaining the discontinued machine. Using this finding, we address long term challenges in sustainability in HCI that both designers/producers and users face in producing and making use of computational artifacts.

## Author Keywords

sustainability, appropriation, re-appropriation, adoption, discontinuation, abandonware

## INTRODUCTION

Computational artifacts come and go at a rapid pace in today's computing environment. Software programs are updated on a daily basis; new platforms are constantly developed; and upgraded models with better technology are released not long after the original model. Consequently, outdated and old machines are abandoned. This challenges users to constantly deal with becoming outdated and losing compatibility with the surrounding environment. At the same time, this causes environmental concerns such as indiscrete use of resources and increase in waste. From a positive standpoint, we see this as an indication of rapid advancement of technology. However, it brings about a number of sustainability challenges that the field of HCI has just begun to address [5].

Challenges and goals regarding sustainability in HCI can be addressed in twofolds: designing interventions for global concerns in environmental sustainability and designing sustainable computational resources. The goal of the former

includes activities or product designs that help individuals and groups to become more knowledgeable about the environmental problems such as pollution, water, and waste control that we face today. (Examples of this type of intervention include sharing rides [6] or helping citizens to make informed decisions through simulated models [3]). The goal of the latter includes prolonging the life cycle of a computational product to reduce waste and in general to support long term use of a computational product [2].

However, re-use of devices or prolonging life cycle of products may confound with industries' profits, which can lead to delay in the advancement of technology. For users, keeping up with rapidly updating computing environment requires a large amount of effort. Finding the balance between the two will be challenging, but is crucial for sustainable design. To discuss these challenges in a grounded manner, we first briefly introduce our study on users of a discontinued palmtop computer. Through a large email archive, this study informed us with user decisions in appropriating and maintaining a dying machine.

## HP200LX AND ITS MAILING LIST

HP200LX (LX) is a small, shirt-pocket sized palmtop computer housed in a clamshell-style case introduced by Hewlett-Packard in 1994. The LX offers DOS compatibility with minor exceptions, and is equipped with a standard QWERTY keyboard, a 640 x 200 4-shade gray-scale LCD display, serial ports, and PC-card slot. Two AA batteries can run the LX for 30 to 40 hours. The default LX comes with an Intel 80186 central processing unit which runs at 7.91 MHz and with 1 MB of memory, of which 640 KB is RAM and the remainder is available for expanded memory or storage space. However, both the central processing unit and memory chips can now be upgraded to 15.8MHz and 64MB with aftermarket products.

In 1999, HP discontinued the LX due to a new Windows CE product line that was introduced in 1998. In reaction to the company's decision, in June 1999, a street rally was organized in Japan in front of HP's Tokyo headquarters with the signatures of 761 people protesting against the discontinuation. Even after the discontinuation, the LX users continued to maintain and develop the LX both in

hardware and software with the help of third party companies and expert users who are willing to volunteer their developmental efforts. The LX users communicated mainly through a mailing list called HPLX-L, which in the beginning of 2008 had accumulated over 90,000 messages. They also shared information on the LX through online magazines and personal websites. For our analysis we read a total of around 4,000 messages sampled from various points of time in the mailing list, and looked for patterns and emerging themes using standard qualitative method [1].

### **The mailing list members**

The LX users on the list we observed are mostly middle aged male professionals working in medicine, economics, and IT, who live mostly in the USA and Europe. The central core of list members consider themselves technology-savvy users, which is distinct from the "general users". After Windows CE came out as a mobile platform, the LX running DOS became increasingly outdated, losing compatibility from the surrounding computing environment such as wireless technology, connection to printers and desktop machines, and a variety of applications. It was up to the LX users to either conform to the changing environment and adopt a new platform or continue using the LX, in which case the users themselves were responsible for any developmental efforts and dealing with compatibility. If we look at the trend of the activity of the mailing list, over 250 users have posted messages per month during the peak times in mid-1997. Surprisingly, according to the list manager, there were around 400 users still registered on the list in November 2007, which is 8 years after the discontinuation. However, the number of posting users has decreased to 39 per month.

The users who continued to stay on the list were constantly weighing the trade offs between the lack of compatibility and support versus the strengths of the LX: 1) the vast amount of collective developmental efforts in LX applications, 2) the transparency that the DOS platform has that not many of other mobile platforms have, and 3) the satisfying form factor including the size of its keyboard and screen. While making the trade offs, the LX users had to continue exerting tremendous effort to appropriate and maintain the LX as one of their everyday computing resources. The following describes this work in detail.

### **Negotiated appropriation work**

Negotiated appropriation work [4] is a term we used in describing users' constant work of trading off between appropriation and maintenance versus looking for an alternative device. This involved various types of work that we believe not only discontinued machines but also any everyday computational resources require. Studying the LX users illuminated issues of continuing use of an aging machine in a more general context:

**Dealing with an aging physical platform.** Many, if not all users, must be concerned about replacing aging or failing equipment, fixing broken parts, backing up and repairing drives, and the like.

**Understanding how to maintain functionality in the face of changing equipment and environments.** Users must constantly download drivers, patch security holes, and maintain their software environments for a large number of computational devices.

**Creating functionality to conform to changing environments.** Users must determine compatibility among machines, fix connections, ensure new data standards are met, and the like.

**Creating desired, new functionality.** Many users are constantly looking for new things to do and new ways of doing old things. They must weigh the difficulty of finding new functionality against the cost of changing their activities.

**Understanding alternative platforms, their capabilities, and the tradeoffs.** Users end up constantly trading off new capabilities with the familiar, and one possibility against another. Not every individual does this consciously, of course, but many are aware, at some level, of features and possibilities.

Next, we describe how this work informs sustainability.

### **CHALLENGES IN SUSTAINABILITY**

The following describes the challenges we were able to derive from negotiated appropriation work in designing sustainable computational artifacts:

- Appropriation and maintenance work of the users often require technical expertise
- Compatibility with the surrounding environment needs to be maintained on a constant basis
- Fixing and upgrading hardware and software become harder once the machine starts to age
- Time and monetary cost of maintenance cannot be ignored
- Balancing between industries making profits and not overwhelming users with fear of becoming outdated is not an easy task
- Enhancing compatibility between old and new devices makes it harder for developers to make a leap in technology advancement

In the workshop, we hope to share these challenges as starting points of brainstorming ways to overcome the challenges in supporting re-appropriation, maintenance, and prolonged life of computational artifacts.

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