Fluid technology design for development

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ABSTRACT
Designing learning technologies for developmental contexts is a difficult problem. Based on an analysis of the development of the Zimbabwe Bush Pump [1], in this paper we apply the concept of 'fluidity' to technology design. The underlying principles are detailed and their relationship to issues in human computer interaction discussed.

Categories and Subject Descriptors
H.5.2 [User Interfaces]: Evaluation/methodology, Graphical User Interfaces, Input devices and strategies, Interaction styles, Prototyping, Screen design, Standardization, Style guides, Theory and methods, User-centered design

General Terms
Design, Human Factors.

Keywords
Development, developing world, Africa, Asia, participatory design, Human Computer Interaction, Fluidity.

1. INTRODUCTION
There is an increasing interest in the design and development of new technologies for use in developing countries (for examples, see: http://www.bgdd.org). Two of the largest exemplar projects are the One Laptop Per Child (http://www.laptop.org) and Intel's Classmate PC (http://www.classmatepc.com). With such a high level of investment from those in both developed and developing contexts, it is critical that new technologies are designed using appropriate principles.

Within the wide HCI community there is a general recognition of the need to move from "traditional" HCI methodologies, which primarily focused on improving usability to a newer model that emphasizes the centrality of the social [2]. The subfield of HCI for development (HCI4D) can be viewed as an instance of this shift. A starting point for many HCI4D projects is human- or user-centred design (H/UCD). Broadly, this approach postulates that applications are designed based on the needs of the user. However, [3] have pointed out that UCD as a methodological approach has primarily focused on Western ideals of what is useful. They state (and we agree) that this entails that the traditional view of UCD needs to be broadened in order for it to be "culturally appropriate" in a variety of contexts.

A concrete example of a project that has attempted to adapt UCD is 'Text-free user interfaces for illiterate users' in India [6]. Primarily, Medhi argues for design principles that account for the subtle but critical socio-cultural issues faced by users in this context. The paper offers a set of lessons gained from their experience, for example "creating a conductive environment for usability testing". While this research is a productive step in the right direction, it does not detail how HCD is to be augmented at a more general level.

Building on our work on interdisciplinary design practice [5], this paper proposes a way to think about design and development of new technologies. It places the concept of *fluidity* at the centre of the process *and* the design solution.

2. SOCIAL STUDY OF TECHNOLOGY
Generally speaking, the social study of technology (SSOT) involves the application of social theory and research methods to analyse the interrelationships between people and technology. This paper is anchored with the view that SSOT research can provide a mechanism by which the subtleties of social contexts can be more readily understood by those involved in the emerging field of HCI4D. In particular, the design and development of (old) technologies that have a long track record of successful deployment in the developing world may provide critical pointers for our community. One such technology is the Zimbabwe Bush Pump (ZBP) [1].

2.1 The Zimbabwe Bush Pump
The ZBP was designed in 1933 by Tommy Murgatroyd for "simplicity, durability, and ease of maintenance". Today, approximately 32,000 pumps are in use including some of the originals. The current version, the B-type, is locally produced, made of steel and wood and can pump water from wells up to 100m deep. The underlying complexities of hydraulics are hidden from the user; they simply operate the handle to pump water. It pays attention to local customs: for example, the manual states that local water diviners should be consulted before any decision about the site of a water hole is made. This emphasizes the critical aspect of community participation. Moreover, the villagers are responsible for the pump's installation, operation and maintenance, and jointly own it.

In this short summary of the ZBP, aspects of its success can be delineated. However, in order to put these on a more conceptual footing, the concept of fluidity is introduced.

2.2 The concept of fluidity
The concept of fluidity is important in the process of designing "appropriate technology". At the first level, an object is a *fluid object* when it is adaptable, flexible and responsive to the context in which it is placed. Second, a fluid object is not rigourlessly bounded – it helps shape the socio-technical landscape through its functionality and through the activities associated with it. Perhaps most importantly, fluidity forces the designer to think through what the functionalities of the technology really are. Often they extend and are deeper than first conceived. As an example, take the mechanical functionality of the ZBP – the user propels the lever and water flows. Its mechanical parts define the boundaries of the pump. However, these are permeable in the sense that they can be replaced with whatever is at hand and the ZBP will still work.

The ZBP then is not a solid, rigid object but one that is fluid, malleable by its surroundings. However, caution with the notion of fluidity is warranted. Fluidity implies a constrained set of configurations in the socio-technical landscape, in particular the designed technology must have a clearly perceived utility for the community.

3. FLUIDITY AND HCD

The concept of fluidity provides a way to begin to think about how HCD can be adapted to the developing world context. As Marsden [4] points out there are severe difficulties for doing participatory design in developing countries. We argue that the following aspects of fluidity may prove useful not only throughout the design cycle but also when the technology is deployed:

Clear and Present Need: the design process and technology to be designed should be seen to clearly address a current community need. For example, communities with abundant cheap water might be expected to have little interest in owning, learning about, repairing and adapting the ZBP.

The potential for "ingenious" adaptation: the design of the technology should have the scope to enable it to be adaptable to local needs. In this case of the ZBP, ordinary steel parts can do the job of some of the bolts. How might ICT4D technologies generally and HCI components more specifically be customized in this manner?

The place of the community: providing a role for the community (often the village) in the on-going use and maintenance of the technology is vital to its sustainability. With the ZBP, communities were required to maintain it. For this to be a success organization of roles and responsibilities was needed and in doing so the ZBP *constituted its own community*. If this community building aspect fails, then the technology fails.

No unnecessary complications: for a fluid technology to be successful it must be simple: "the designer knows when he has reached perfection, not when there is no longer anything to add, but when there is no longer anything to take away" [1].

Ownership and access: a key part of the success of the ZBP is that it is open source. The design is not patented and its designer has never claimed he designed it. "The people" own the pump: they pay for it to be produced but they do not pay for the right to use it. It is a national resource.

Distributed action: implementation of technology requires that methods and insights of the local community are paramount. The designers of any technology need to "abandon control" so what they are working on doesn't end up being "new and foreign". This is a long-term effort and not solely for the purpose of the design cycle.

4. WATER MANAGEMENT SCENARIO

Here we explore aspects of fluidity with reference to a scenario for the participatory design of appropriate technology with a rural community in a semi-arid area of rural Kenya.

Clear and Present Need: Initial studies in the community identify the most pressing concern to be water and how to grow food successfully in a dry environment. The design process clearly communicates how it and the technology developed will address this need. Initial activities involve the community in mapping local water resources and studies with technology prototypes employ high quality localized water management and arid land agriculture educational content.

The potential for "ingenious" adaptation: This content is also made available disaggregated and in multiple media (text, audio, video, image) and the tools, training and permissions to edit and adapt these are provided.

The place of the community: In this community local language radio is widely listened to, many people have access to a mobile phone, local community groups hold public meetings to disseminate knowledge. The design process and designed technology interface smoothly with these local communication channels. Content is delivered to members of the community who participate in these channels and they take responsibility for localizing, modifying, adapting and passing it on.

No unnecessary complications: The designed technology and associated educational activities encourage the learner to reflect on their experience and make it easy to pass knowledge on. Part of the reflection process is simplifying the message (both for the community and the technology designer). For example, a farmer who learnt to grow melons from the radio shows her crop to a neighbour and chats about how she cultivated them.

Ownership and access: Content is freely available to both local and global communities. Local adaptations and reflections on the content are captured and made accessible globally. Global comments, adaptations and additions to the content database are delivered locally.

Distributed action: Through reflection and adaptation the local content users become content creators and owners. Their own stories of how to grow a melon in an arid land are shared both locally and globally.

5. ACKNOWLEDGMENTS

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