A dialectical take on artifact ecologies and the physical-digital divide

Susanne Bødker & Clemens Nylandsted Klokmose
Department of Computer Science
Aarhus University
Åbogade 34, 8200 Aarhus N, Denmark
{bodker, clemens}@cs.au.dk

Abstract
In this position paper, we will present and discuss our understanding of artifact ecologies as we have developed it, rooted in activity theoretical HCI and dialectical thinking. Our basis is in the Human-Artifact Model, as well as well as cases where we have worked with artifact ecologies in analysis and design of computer mediated activity. The paper concludes with a positioning of our perspective vis-a-vis the notions of natural and blended interaction and the physical-digital divide.

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Artifact ecologies, activity theory, dialectical thinking.

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Introduction
Our starting point in this position paper is in computer mediated human activity. It is increasingly clear that in order to analyze and design technological artifacts it is not sufficient to look at one artifact at a time, and one new artifact as substituting or replacing another. Human beings surround themselves with many artifacts, in many everyday activities, and what artifact is 'natural' for them to use, is highly dependent on their individual past experiences, as well as of the shared practices in which they are part, and the technological possibilities offered to them, in (and outside) these communities of practice. In order to understand better what is at stake here, we have, for the past years, worked both theoretically [2, 6, 9, 10] and empirically [3, 5, 7, 8] to identify the changes happening as communities of practice embrace new technologies, and to design new technological artifacts into this space. This is the motivation for looking deeper into computer mediated activity and artifact ecologies.

The word ecology is borrowed from Gibson [14]; see the discussion in [4]. In the Gibsonean sense, our (visual) perception is shaped by our physical ecology and cannot be understood in isolation. The ecology of a subject is the part of the physical world that it interacts with to realize its life. Following Gibson's definition of ecologies, Jung et al. [18] define a person's ecology of artifacts as the artifacts "… that a person owns, has

access to, and uses". In our understanding of Gibson's work ecologies are not individual however, and hence neither are artifact ecologies.

According to activity theory, users' shared capacities and experiences are not only based on individual acting and learning in the world: People act in cultural situations where they get to share practices, and the role of the more capable peers is important in this [4, 9] - this is *praxis*. Characteristic to the *dialectical thinking* of activity theory, each individual, who is part of such praxis, continues and develops this praxis. When we look in further detail at the relationship between the user and the artifact, it is on this background: There is no user without other users who share their experiences with artifacts and materials, understanding, etc.

The artifact ecology is shaped by and in a web-of-activities, or overlapping communities of practice, where the same artifact can be part of multiple activities, or artifacts can be *substituted* [10] for each other to realize the same activity. Web-of-activities are highly dynamic. In [4] we discuss this dynamics and develop an understanding of the development of artifact ecologies among iPhone users.

If we think of the artifact ecologies we surround ourselves with, they most often consist of multiple artifacts built for similar purposes but with slight variations and no clear delineation of when to use which artifact–e.g. various maps [3]. The specific choice of artifact that users may make is situated and depending both on the material conditions of the activity and on the specifically intended outcome. The artifact ecology is in continuous development. Artifacts come and go; they can break and be replaced, or their function becomes obsolete due to changing circumstances, activities or because of newly acquired skills.

Every artifact contains the germ of a new practice and remnants of old practice. Bardram & Bertelsen [1] use the concept *initial familiarity* to describe the phenomenon of how new artifacts or artifacts used in a new use situation can trigger re-application of previously learned actions. Initial familiarity can be constituted in interface design through playing on simple affordances or e.g. interface metaphors. According to Gal'perin [13] the scaffolding for the further development of use is constituted in the mediating artifact as well as socially e.g. through more capable peers. According to Engeström [11] the tension between the given new (the artifact being explored in this case) and the expected new as what ultimately drives change. This dialectics is an example of the dialectical method of reasoning that aims to understand things concretely in all their movement, change and interconnection, with their opposite and contradictory sides in unity [9].

Human activity is mediated and in our work, we have developed and used the Human-Artifact Model [9] as means to analyze the use of artifacts in context of use and their artifact ecology. The analytical scheme of the Human-Artifact Model combines analyses of human experiences and artifacts, and addresses the tensions between human skills and capacity on the one hand, and the action possibilities and affordances offered by the artifact on the other [9]. This is done on three levels reflecting the activity hierarchy: activity, action and operation. The focus of an analysis with the

Human-Artifact Model is on tensions between the experiences of a user and the assumptions of use embodied in the artifact on all three levels of activity.

In [4] we discuss how the use of artifact ecologies evolves dynamically over time. Based on a study of iPhone users, we conceptualize this dynamism as three states that artifact ecologies iterate through. We have learned that to fully grasp how artifact ecologies evolve, we need to encourage longitudinal studies of artifact ecologies over years.

Artifact Ecologies and Physical vs. Digital

Recently we have seen numerous discussions on what makes user interfaces "natural" or "intuitive" [16, 17] particularly in the light of the increased complexity of interaction design in the wake of ubiquitous computing, post-desktop, post-WIMP computing. One of the prominent takes on what makes a user interface feel "natural" is when it draws on our experiences from the "physical world" or the "reality" as Jacob et al. puts it. Imaz & Benyon [15] and Jetter et al. [17] has applied Fauconnier and Turner's [12] theory on *Conceptual Blends* as a vehicle for explaining how users rely on familiar and real-world concepts whenever they learn to use new digital technologies. Jetter et al. [17] are particularly interested in how to create effective blends between our experiences from the "physical" world with those from the "digital" world.

We find the theory of Conceptual Blends a welcomed addition to the theoretical repertoire of human-computer interaction, and it harmonizes well with the more simplistic notion of "initial familiarity" that we previously have built upon. However, we believe that the dichotomy of the "physical" and "digital" world is problematic from an ecological and particularly a dialectical materialist perspective. Jetter et al. acknowledges this problem:

"So far, we strongly focused Blended Interaction on building on users' pre-existing knowledge of the everyday, non-digital world and our sensorimotor experiences of it. This seems to imply that we clearly distinguish between the non-digital, physical "reality" that is easy to understand because we are all familiar with it and the "unreal" and "magic" world of computing whose disembodied concepts can only be understood after committing far more cognitive and intellectual resources. However desirable such a clean separation may be, it would lead to a too simplistic view: We believe that we cannot consider our "reality" as free from digital influences anymore." [17](pp. 9-10).

They continue to give examples of how previous experiences with digital technologies shape the perception of new, and acknowledge that interaction design must rely on both blends between experiences from the "physical world" and blends between previous "digital" experiences.

We do not believe the distinction between the "physical" and "digital" is fruitful, and we believe the distinction can be overcome through a dialectical materialist understanding of how our perception is shaped through our artifact ecology. From this perspective there is no difference between experiences made with a paper map, and experiences made with the GPS in the car when appropriating, or designing a new map technology–which were evident from our own studies of map use [3]. Hence, creating a successful new map technology will require creating meaningful

conceptual blends based on the intended users material experiences in past and present artifact ecology. In our current work we are exploring how the Human-Artifact Model can serve as a theoretical framing for analyzing conceptual blends in interaction design and human-computer interaction, and how the combination of dialectical materialism and an ecological approach can conceptually bridge the physical-digital divide.

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