Composition and mediation in cross-surface interaction

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Abstract

In this position paper we propose two perspectives on interaction in cross-surface systems: compositon and mediation. We advocate for a focused effort to expand our theoretical and analytical vocabulary when it comes to cross-surface interaction.

Author Keywords

Cross-surface interaction; device ecologies; analytical tools

ACM Classification Keywords

H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous

Introduction

Over the years we have build, deployed and studied a number of multi-device and cross-surface systems 'in the wild'. We have seen how the roles of devices and surface, whether large or small, can differ quite significantly given the use case and application: A personal device may e.g. provide a private interface for interacting with shared surfaces (as in our own Local Area Artworks [2]) or become part of a shared distributed interface (as in HuddleLamp [6]). Our vocabulary for talking about human-computer interaction beyond *one user—one device* is still limited, and we believe it is important to continuously refine and expand this vocabulary. In this position paper we propose two analyti-

cal perspectives on interaction with cross-surface systems: *composition* and *mediation*.

We build upon a growing body of work on taxonomies and theoretical frameworks for post-desktop, multi-device and cross-surface interaction. Notably Terrenghi et al. [9] examine multi-display ecosystems with the intent of understanding the relationship between scale (form-factor), social interaction and the interaction methods that couple devices and displays and make interaction possible. Müller et al. [4] have developed a taxonomy capitulating how people perceive public displays, interaction modalities and supported interaction. Sørensen et al. [8] present the 4C framework for (collaborative) interaction in digital ecosystems. The 4C framework derives principles of interaction design in digital ecosystems from a 2x2 matrix of 'many users' vs. 'many artifacts' and 'sequential' vs. 'simultaneous interaction'. The themes of the quadrants are communality (many sequential users), collaboration (many simultaneous users), continuity (many sequential devices) and complementarity (many simultaneous devices).

Theoretical premise
This work is part of our ongoing efforts in trying to grasp and theorise on the relationship between human activities and the role artifacts play. This work is strongly positioned within an activity theoretical understanding of activities, mediation and cultural-historical analysis of artifacts as crystallised knowledge. The core tenet of activity theory is that artifacts mediate human activity and that in order to understand artifacts we take the activity they are part of as the minimum meaningful unit of analysis. If a given artifact, device, software application, service etc., is used in an activity, we take that it has a meaningful instrumental role in the context of the activity, as it mediates intentional action and help users to realise specific goals.

With the proliferation of personal and ubiquitous computing, the artifacts available and their capabilities have changed significantly. In previous empirical work we have described these systems as artifact ecologies and made tentative distinctions related to some of their characteristics. The concept of artifact ecologies is socio-technical and encompasses both the actual technologies and how they are appropriated and used in meaningful activities. In the empirical and theoretical work, we have primarily focused on social aspects, e.g. the dynamics of personal artifact ecologies [1] and how a community appropriate and use multiple artifacts as part of their activities [3]. Individuals have a rich personal ecology of devices, although not always an active part of the activity at hand. Throughout an activity, a person only uses a subset of their ecology depending on the activity. We posit that the active artifacts are selected through an (unconscious) assessment between what is to be accomplished in a given activity and the potential artifacts knowingly available to the person – in the situation and in their knowledge of the artifacts capabilities. Here we distinguish between the *potential* and *actual* artifacts available to and used in a given activity. The potential is the "pool" from which an individual or group selects the actual artifacts to be used within the activity at hand (see also [7] on constellations of artifacts and group negotiation), and the actual artifacts are those that are part of the specific activity.

Perspectives on cross-surface systems
In the following we outline two perspectives on cross-device systems and artifact ecologies.

Composition. The composition is the actual artifacts in use as part of an activity. It may span multiple personal and shared devices which may or may not share resources or technical coupling. The composition might involve dedicated devices developed specifically for the particular activ-

ity or may be more or less impromptu use and coordination across heterogeneous devices – personal and shared. The composition of cross-device system changes as the activity changes and the individual devices might change role in the activity. The changes can either be adding, removing or substituting a device. Here we distinguish between a *horizontal* and a *vertical* change in the composition. When horizontal changes occur the base functionality of the multi-device system and its role in the activity does not change. Participants may add another device with identical capabilities of an existing, e.g. adding a larger display or another tablet that can interact with a specific component. A vertical change is when functionality is added or removed to the activity and system, e.g. adding a sketchpad or digitizer to a system that allow participants to embed sketches within a document. Understanding how the composition changes and what parts of the potential ecology (personal and shared devices) are active and the role they play are extremely important in supporting individual and collaborative activities and the various transitions that occur.

Mediation. Cross-surface systems mediate activities of people with certain goals and motives. We characterize the relationship between people to be either: *individual*, *social* or *collaborative*. Individual interaction with a cross-surface system is e.g. to distribute a web page across multiple personal devices [5]. Social interaction is where the interaction is influenced by the actions of others, but not directly affected. E.g. when posting images from personal devices to a public display. Finally collaborative interaction is when there is a common goal and interactions are directly affected by other users, e.g. collaborative editing of text on a shared display [2].

The way goals are realized mediated by the system we call the *instrumentality* of the interaction. Interaction can be *consumption* of digital content through reading, watching or listening; *communication* with other users through a digital medium either synchronously or asynchronously; *production and manipulation* of any kind of digital content, whether text, images videos etc.; *control* of the state of a system, whether digital (e.g. playback of a video) or physical (e.g. controlling the lighting of a room); *search and retrieval* of digital content; and finally *configuration* of a digital workspace (e.g. personalization or window placement). Each of the aspects of instrumentality can naturally not happen in isolation: search requires consumption, consumption requires control etc.

Some discussion

Returning to the 4C framework [8], here the focus is almost exclusively on collaborative control and consumption in their Netflix example; a screen is used for watching a movie and smartphone apps are used to control what is being watched. The composition of the example used in the 4C paper is simple and the capabilities/role of the artifacts are closely tied to the instrumentality of the system. In this case adding or removing a control device would be a horizontal change, whereas adding a device that allowed to review and discuss the movie would be a vertical addition to the composition. Note that this might already be possible within the system, but has to be actually used as part of the activity to be a part of the composition.

A recent study shows that while it is commonly assumed that the larger the surface the better for collaborative sense making, this may not be true for cross-surface situations where sense-making and search and retrieval are distributed across personal and shared surfaces [10]. This means that mediation and composition influence the affordances of interactive surfaces, which emphasises the need for being able to articulate them.

Not all combinations of mediation and composition are common-place today. Collaborative, cross-surface production and manipulation of digital content is rarely seen. This may point to a deeper challenge, namely that our tools for production and our understanding of those tools are deeply rooted in traditional personal computing.

Going forwards

Our own everyday confusion in articulating and working with cross-surface/multi-device perspectives on computing are motivating us to develop a conceptual framework that allow us to analyse and design novel systems within this space. This position paper attempt to do just that anchored in familiar theoretical territory. By basing our tentative vocabulary in activity theory we want to emphasise activities, and not individual use, as a primary focus. This is also an attempt to identify what's next in computing and in particular, how to address some of the fundamental (design) flaws of personal computing and move forward.

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