Metaphors, materialities, and affordances: Hybrid morphologies in the design of interactive artifacts

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As materiality of interactive artifacts is diversified with integrated physical and digital materials, metaphoric design approaches in Human–Computer Interaction (HCI) go beyond resembling the appearance of physical objects, exploring novel materials and forms of interactive artifacts. The hybrid materialities and forms of artifacts influence how interactivity is perceived, reframing the concept of affordances according to its evolving relationship to metaphors and materialities. By conceptualizing interactive forms in their surface, behavioral and systemic aspects, we examine multifaceted roles of metaphors in HCI from concealing and revealing a formal system to expanding and reifying its meaning; and propose a morphologic perspective on affordances as an invitation for making variations of interactive forms by compositing multiple design resources.

Keywords: design rationale, design theory, interaction design, interface design, materialities

In Human–Computer Interaction (HCI) design, the use of metaphors began as a way of communicating to users what a computer application could do by linking it to something already familiar to the user. A prime example is the desktop metaphor in computing: it conveyed its similarity to the physical desktop through its spatial and file-based information organization, graphic icons and menu labels; and it was similarly amenable to the workflows and activities associated with traditional offices. Beside representing abstract concepts in familiar and concrete forms, metaphors, as part of human way of conceptualizing one thing in terms of something else (Lakoff & Johnson, 2003), have been used for bringing new perspectives to product design by integrating disparate source and target entities (Hekkert & Cila, 2015). Many studies propose systematic design strategies for metaphor selection and conception by specifying *metaphoric means* in terms of which aspects of a product a metaphor is applied to (e.g., form, interaction, movement,

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sensory modes) (Hekkert & Cila, 2015); by sorting through different ways of applying metaphors depending on how our embodied experience in the physical space is applied to interface design (e.g., orientational, ontological, structural) (Barr, Biddle, & Noble, 2002); and by viewing design practice itself as different metaphoric concepts to inform design processes (e.g., design as problem-solving, design as idea-generation) (Hey & Agogino, 2007).

While the desktop metaphor has been successful in popularizing the computer at work for the target user group, alternative metaphors are constantly sought for to accommodate diversified forms and meanings of the computer. On the other side, the use of metaphors in HCI design has been controversial for a few reasons: metaphoric user interfaces veil the actual computing system from its users, potentially confusing or misleading the users (Blackwell, 2006); many metaphors are hardly scalable to complex interactive systems that involve abstract concepts such as processes, relationships, services, and transformations (Cooper, Reimann, Cronin, & Noessel, 2007: Ch. 13); and the source domain of metaphors could limit the design and the interpretation of digital artifacts, which can do far more than analog objects with their computational features (Jung, Kim, Chan, Li, & Zhang, 2016). Moreover, the success of a metaphor in HCI, not only confined to the design of a single computer application, depends on how the application is perceived and used in the network of other things (Blackwell, 2006). The network aspect of digital artifacts calls for new metaphors in HCI that concern the relations among multiple artifacts.

A theoretical reflection is needed to understand metaphors applied to diversified materialities and to unravel various design dimensions involved in HCI (e.g., technical, esthetic, cognitive, and experiential aspects). The lack of theoretical reflection leads to only a few proven interaction or interface metaphors replicated across different media with little consideration about their material properties; and multifaceted roles of metaphors in connecting them remain unclassified, even confused with other concepts including formal patterns or image schemas. It is hard to prescribe and evaluate a metaphoric design process based on separate theories like mental models, visual representations or affordances. By synthesizing related theories toward a design-oriented perspective, this study investigates the evolving relationship between metaphors and materialities of interactive artifacts and their influence on the perception of affordances based on the following propositions.

1 Propositions relevant to shape of interactive artifacts: metaphors, materialities, and affordances

Morphology refers to 'the study of shape', and accordingly we find it relevant to discuss morphologies for the design of interactive artifacts. In particular, we focus on the notions of form and meaning in this study about shape of

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