The Importance of Metaphors for User Interaction with Mobile Devices

Chrysoula Gatsou(✉)

Faculty of Fine Arts and Design, TEI of Athens, Athens, Greece
cgatsou@teiath.gr

Abstract. The use of metaphor is essential in user interface design, particularly for the mobile landscape, as the visual environment continues to be populated with more and more mobile electronic devices. A metaphor allows us to understand one concept in terms of another. Although considerable research has gone into the mobile technology, little attention has been paid to mobile interface metaphor, which is the key to user interaction. This paper explores the role of metaphor in interfaces in facilitating user interaction with mobile devices. It presents a classification of metaphors. It also proposes a framework with salient factors in relation to visual communication with metaphors. It also offers some thoughts on the use of new metaphors.

Keywords: Metaphors · Mobile devices · Visual communication · Mental models · User experience

1 Introduction

Mobile devices are now an essential part of our daily life. Recently there have been rapid developments in the direction of more intuitive and seamless interface designs. Areas of research that have emerged from this include ubiquitous computing, intelligent environments and tangible user interfaces. The use of metaphor is essential to user interface design, particularly in regard to the mobile device landscape, as increasing numbers of mobile electronic devices continue to populate the visual environment. Metaphors offer a rich domain within which to construct interactive mobile interfaces and to tackle problems that users often face when using mobile applications.

As devices get smaller and more ubiquitous, the metaphor of the desktop is becoming increasingly unwieldy when applied to handheld devices, mobile phones, and mobile environments [1]. Brewster et al., note the inadequacy of desktop metaphors when used in relation to information presentation in mobile computing [2].

Metaphors should suit both the functional needs they serve and their natural environment. A mobile-phone type interface on a computer with a large monitor is as illogical as a large monitor-style interface on a mobile phone. Metaphors are effective tools for facilitating mutual understanding in communications. They are the tools by means of which people give symbolic form to abstract concepts, so as to communicate them in a comprehensible manner.

This paper explores the role of metaphor in interfaces with the aim of facilitating user interaction with mobile devices. The paper opens with a literature review, which

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establishes the theoretical background for the study. It then offers a classificatory schema of metaphors, suggests a framework with factors relevant to visual communication through metaphor. It offers some thoughts on the use of new metaphors before offering some conclusions.

2 Background

2.1 Metaphors

The word 'metaphor' derives from the Greek μεταφορά (metaphora), which means exactly 'transferring' or 'conveying'. Aristotle's definition of metaphor is still highly applicable today. He notes that a "metaphor consists in giving the thing a name that belongs to something else" [3].

The first modern theorist to introduce the idea that the use of metaphor is all-pervasive in language and that metaphor is a cognitive mechanism was Richards. According to Richards, metaphors consist of two parts: a vehicle and a tenor. The vehicle is the concept that we are familiar with and the tenor is the concept to which the metaphor is applied [4]. Lakoff and Johnson's conceptual view of metaphor has largely dominated the field since the 1980s. In their view, metaphors are systematic thought structures that link two conceptual domains. The *'source'* domain is essential in structuring the *'target'* domain through a metaphorical link, or 'conceptual metaphor' [5]. Erickson furthermore notes that metaphors *"function as natural models, allowing us to take our knowledge of familiar, concrete objects and experiences and use it to give structure to more abstract concepts*" [6].

Metaphor is not just a literary matter, however. It is fundamental to the way we think. In the development of interactive systems, we are constantly trying to describe to others a new domain, such as a new application, a different design or new interactive facilities. Thus we have to use metaphor to explain this new domain in terms of something that is more familiar. In Blackwell's view, within a few years the metaphorical use of a term becomes established in the language to such an extent that one forgets that was a metaphor before [7].

2.2 Mental Models

Marcus and Gould note that user interfaces consist of the following components: metaphors, mental models, navigation, interactions and appearances. Metaphor is the use of a familiar concept to explain a new one [8]. The term "mental model" has been used in many contexts and for many purposes. It was first mentioned by Craik in his 1943 book, *The Nature of Explanation* [9]. Leiser argues that a mental model of a user interface consists of a set of representations of the relationship between user actions and system responses [10]. This view rests on Johnson-Laird's view of mental models as a form of knowledge representation and their manipulation as a form of reasoning, in which a mental model is regarded as the set of possible representations of the available information [11]. Mental models have been used in human-computer interaction and have resulted in increasing usability. Staggers and Norcio propose definitions of users'

mental models that base the users' models of a system on their experience of the system [12]. According to Cooper *et al.* the closer the represented model comes to the user's mental model, the easier it is to understand the programme [13]. Figure 1 shows the implementation or system model, the user's mental model and the represented (designer's) model. The designer is called in to bridge the gap between the two.

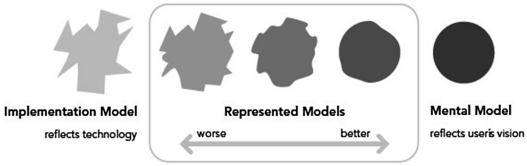

Fig. 1. The represented model (Cooper et al., 2007)

2.3 Why Metaphors are Important

Carroll *et al.* suggest that the metaphor approach *"seeks to increase the initial familiarity of actions, procedures and concepts by making them similar to actions, procedures and concepts that are already known"* [14]. Metaphor, far from being merely a literary device, is fundamental to the way we think. In the development of interactive systems the designer is constantly called on to describe to users a new domain, such as a new application, a different design or new interactive facilities. Thus one has to use metaphor to explain such new domains in terms familiar to the potential user.

When considering the idea of navigating an interactive system, many people immediately think that navigation consists of attempting to reach a specific destination, in the way in which internet users navigate or explore as they follow links from one place to another. The metaphor used in the iPad (iBooks) drives the user clearly to select a book (Fig. 2).

Fig. 2. Mobile interface metaphors

However, some metaphors used by the iPad are ambiguous. Few potential users, for example, know what the green button labelled "SkyGrid" means. On the other hand, the file sharing tool Dropbox makes use of a metaphor to explain their services to the potential user. In the Dropbox name and logo reference is made to a 'Dropbox', that is, a box into which one can drop things, everyone being familiar with the concept of a cardboard box to store things. Dropbox has adapted this concept and transferred it to an

online tool that stores documents. The increase of mobile devices and multiple functions forces designers to develop new modes and modalities of physical interaction techniques [15].

3 Classification of Interface Metaphors

When considering research into interface metaphors, it is important to draw up categories in order to make the study of important material more comprehensible. The classification of common metaphors is part of an effort to facilitate the design of more efficient interfaces. In 1980, cognitive linguists Lakoff and Johnson established the conceptual metaphor theory, which they called 'cognitive metaphor theory' [5]. They argued that metaphors are both pervasive in language and are essential part to our conceptual system of thought and action. They introduced three categories of metaphors, ontological, orientational, or structural:

- Ontological metaphors rest on our physical experiences with physical objects. Ontological metaphors help us to represent an abstract thing in terms of something concrete such as an object, substance, container or person.
- Orientational metaphor is a metaphor in which concepts are spatially related to each other such as up-down, in-out, front-back, on-off, near-far, central-peripheral.
- Structural metaphors allow us to structure one concept in terms of another.

In Hutchins' view, "*metaphors reach the user community as ways of talking about the behavior of the system and provide the users with resources for thinking about what the machine is doing"*. He suggested three types of metaphor illustrating different aspects of the human-computer interface [16].

- Activity metaphors refer to the user's high-level goals and structure expectations concerning to the outcome of the activity, for instance, writing a document.
- Mode of interaction metaphors concern the user's view of the computer, for example, whether they regard it as a conversation partner, or an archiving tool.
- Task domain metaphors offer a structure to help the user understand computer-based objects and operations.

Condon and Keuneke focused on interface metaphors and classified them on the basis of the underlying metaphor, rather than the medium in which the metaphor is presented [17]. Their classification involves three categories:

- Spatial metaphors define 2D or 3D spaces, in which interactions and activities take place,
- Activity-based metaphors, which define the actions that can be performed upon the information or people within the space,
- Interactional metaphors, which support specific forms of communication.

Carroll et al. [14] gives three theories underlining research on metaphors:

- Structural approaches interpret the metaphor process in terms of the mapping between the knowledge of target domains and the knowledge of source domains.

- Operational approaches attempt to prove the quantifiable effects of metaphors on user performance.
- Pragmatic approaches primarily focus on what types of objective or contextual concerns might limit the deductive functions of metaphors.

Of all these categories, structural and spatial metaphors have been used most broadly in interface design. The principle of the spatial metaphor is that locating information on the internet involves faculties similar to those employed when navigating in physical space. Furthermore, my own view is that structural metaphors are the most specific of all metaphor types and are also the most sensitive to cultural influences.

4 Factors Affecting Visual Communication Through Metaphors

Cognitive research on interface mobile metaphors has identified a number of significant factors that may fundamentally affect the comprehension of metaphors. On the basis of the literature review above and our own previous research into user visual communication with mobile interface metaphors [18, 19], we focus on three factors, namely culture, context and user experience.

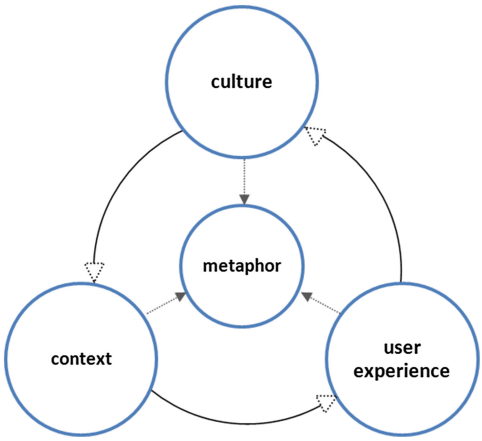

Fig. 3. Factors influencing metaphors' comprehension

4.1 Culture

Cultural differences may make basic metaphors used in a mobile interface design incomprehensible to users from other cultures [19]. Culture is a concept that is difficult to define and measure. In the view of Hofstede and Hofstede, culture is the collective programming of the mind that separates one group of people from another [20]. They

argue that culture can be defined as *"the forms of things that people have in mind, their models for perceiving, relating or otherwise interpreting them"*.

Metaphors present particular problems because images that may be comprehensible in one culture may be unknown in another [21]. The cultural environment of the user consists of their ethnicity, their range of experience, which is related to their socio-economic background. However the author's previous empirical work has found that cultural differences may also is defined by age [18].

4.2 Context

The dynamics of cognitive processes involves the vast number of contexts in which the meanings are constructed. Therefore what something means to an individual depends very much on the context of the interaction. In regard to how users and designers perceive the meaning of products, Krippendorf suggested that *"objects are always seen in a context (of other things, situations and users, including the observing self)"* [22]. Context can influence user interaction at different levels. For example, it can contribute very strongly to whether an experience is positive or negative or to how far users accept the service in question. As Macdonald stresses, visual symbolism is not universal. Perception, recognition and acceptance of an object is determined by the context in which it is used and by the nature and cultural conditioning of the user [23]. Multiple contexts can interact with each other in ways that are not fixed. Preece *et al.* define context of use as *"the circumstances in which the interactive product is expected to operate"*, and include the social, technological, organisational and physical environment [24]. Buxton argues that technologies do not exist in a vacuum. In any meaningful sense, they only have meaning, or relevance, in a social and physical context [25].

4.3 User Experience

Stone *et al.* argue that use of metaphor is pointless, if the physical analogue to the metaphor is outside the user's experience [26]. Any connection with the real world can potentially be used as the vehicle for any metaphor. Users are individuals who have a great deal of real world experience to rely on when attempting to understand matters. Shedroff [27] gives a definition of user experience as follows:

> *"The overall experience, in general or specifics, a user, customer, or audience member has with a product, service or event. In the usability field, this experience is usually defined in terms of ease-of-use. However, the experience encompasses more than merely function and flow, but the understanding compiled through all of the senses."*

In order to compile a full list of potential vehicles, it is crucial to consider exactly who is going to use the application, so as to be able to choose the proper types of vehicles.

Erickson's approach to the overall design of metaphors is first to understand the functionality of the system, then to identify users' problem areas and finally to generate metaphors that might help, evaluating them according to the criteria just discussed [28].

In summary, all these three factors offer a structure that helps in drawing together the various complex aspects involved in the evolution of new metaphors designed to improve interaction with mobile devices.

5 From Mobile Metaphors to Cloud Metaphor

The revolution in mobility and ease of access has changed the user's mental model regarding ownership of files. It has also decreased the importance of where we now save our files. Many files are shared online on websites. For example, there is the *instagram* application, where users upload photos, *Pinterest* or *Google Docs*. (See Fig. 3). Our every day computing activities increasingly involve the use of a Web-based tool, sharing, e-mail, word processing or photo editing. Users may store their emails and other documents on the Web and they can also create links directly to those files to be shared with their friends, family, colleagues or classmates. These new contexts have changed our digital behavior significantly. It is possible that a number of people never open a desktop application. This situation is gradually leading to the design of new metaphors.

Fig. 4. Sharing mobile applications metaphors

As new ways of navigation, searching and organizing personal data appear, people become more mobile, enjoy large amounts of data storage and are able to perform complex tasks anywhere. This change means that users have to deal with the different representations of visual metaphors which have started appearing in mobile applications. Ubiquitous and mobile computing is the post-desktop model of human-computer interaction, in which the information computing and processing functionalities are interlaced within daily activities and objectives.

It is obvious that individuals will want to be able to use many different devices to access data and applications. A mobile cloud can be accessed through various devices. As cloud computing continues to offer an increasing number of services to the user, there is an increasing demand for new design metaphors, driven by the new requirements of cloud computing. This new landscape requires a careful response on the part of designers, so that metaphors will be understood and adopted by the users (Fig. 5).

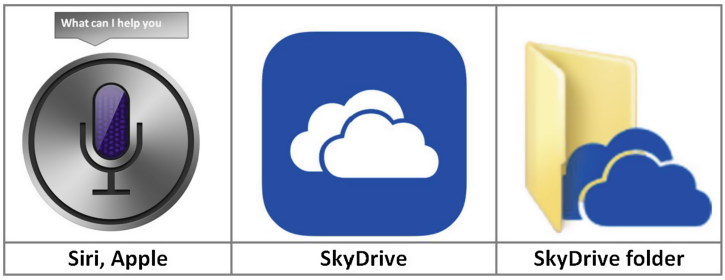

Fig. 5. New mental models for cloud metaphors

Users are required to structure new mental models suitable for the new environment. For example users of the application Skydrive who search for documents files in yellow folders now confront icons consisting of small blue clouds, instead of previous icons (See Fig. 4). Another paradigm is Siri, a voice interaction search service on the latest iOS, which understands its user's intentions and offers him or her the best options.

Moran and Zhai in their article *Beyond the desktop metaphor in seven dimensions* propose seven principles to aid the development of the desktop information model into to a much powerful model that can be used to support user interaction with mobile applications. They propose the idea of a *personal information cloud* [29]. In their second principle "*From desktop to a diverse set of visual representations"* they illustrate the new landscape emphasizing the need for visual representations which represent mobile applications. They argue that *"in the future a variety of advanced visual representations may be adapted to specific problem domains and different device forms, complementing the basic conventional desktop metaphor"*.

In Marcus' [30] view, metaphor is not likely to disappear in the near future. However, its use will expand to designing agents that assist our computing tasks.

This new mobile era demands effective visual communication between new representations of metaphors and users, so as to make user interaction as smooth and easy as possible.

6 Conclusion

The use of metaphors in mobile devices allows potential users to understand possibly unfamiliar phenomena by making associations with familiar objects and feelings. This paper has presented how mobile metaphors can be applied to facilitate human-computer interaction and improve interface design for mobile applications.

The classifications of Lakoff and Johnson [5], Hutchins [16] Condon and Keuneke [17] and Carroll et al. [14] provide starting points for how metaphors can be selected during mobile interface design for user visual communication and interaction. Furthermore we have offered a framework involving salient factors such as culture, context and user experience in relation to a user's visual communication by means of metaphors. The paper also presents some thoughts on the use of new landscape of metaphors like cloud computing.

The outcomes of this study offer a foundation for future research in the area of mobile metaphors. Moreover, there is a clear need for research, given the rise of cloud computing, in order to produce effective representations based on culturally-dependent metaphors.

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