Conceptual Models and Usability

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INTRODUCTION

The study of conceptual models is both a complex and an important field within the HCI domain. Many of its key principles resulted from research and thinking carried out in the 1980s, arguably in the wake of Norman (1983). Since then, the importance of conceptual models in affecting the usability of an Information and Communication Technology (ICT) system has become well-established (e.g., they feature prominently in the widely cited design guidelines for interfaces defined by Norman [1988], which are summarized in Figure 1 by Lienard [2000]).

Today, most HCI professionals are able to attribute significant meaning to the term *conceptual model* and to recognize its importance in aiding usability. However, two problems seem to prevail. First, some HCI researchers and practitioners lack a precise understanding of conceptual models (and related ideas), and how they affect usability. Second, much of the research in this field is (necessarily) abstract in nature. In other words, the study of conceptual models is itself highly conceptual, with the result that practitioners may find some of the theory difficult to apply.

This article is designed to help both researchers and practitioners to better understand the nature of conceptual models and their role in affecting usability. This includes explaining and critiquing both contemporary and (possible) future approaches to leveraging conceptual models in the pursuit of improved usability.

BACKGROUND

Key to understanding the role of conceptual models in promoting usability are clear definitions of these terms, related ideas, and their appropriate contextualization within the HCI domain.

Definitions of Usability

Probably the first widely cited definition of *usability*, as it applies to ICT systems, was established by Shackel (1991) and is shown in Figure 2.

The definition provided by Shackel (1991) is reasonably comprehensive, which is one reason it remains useful today. However, a more concise

Figure 1. Design guidelines for interfaces defined by Norman (1988), summarized by Lienard (2000)

A. Good **visibility** means you can: • tell the state of the system by looking at it • tell what the alternatives for actions are • identify controls to make the system perform the available actions	+
B. Good **conceptual models** provide: • consistent presentation of the system's state • consistent controls, possible actions, and results	**System image =**
C. Good **mappings** mean you can determine the: • relationship between actions and results • relationship between controls and actions • system state from what is visible	**User's model of system**
D. Good **feedback** involves: • full and continuous presentation of the results of actions • timely (i.e., rapid) response times	**A "good" user model makes the user feel:** • **in control of the system** • **confident of getting the required result(s)**

Figure 2. Definition of usability by Shackel (1991)

Effectiveness
Improvement in task performance in terms of speed and/or error rate by a given percentage of the population within a given range of the user's tasks (related to the user's environment)
Learnability
Within some specified time from commissioning and start of user training based upon some specified amount of user support and within some specified relearning time each time for intermittent users
Flexibility
With flexibility allowing adaptation to some specified percentage variation in task and/or environments beyond those first specified
Attitude
Within acceptable levels of human cost in terms of tiredness, discomfort, frustration and personal effort, so that satisfaction causes continued and enhanced usage of the system

definition was established in ISO 9241-11:1998 and is summarized by Maguire (1998):

- **Effectiveness:** How well the user achieves the goals he or she sets out to achieve using the system.
- **Efficiency:** The resources consumed in order to achieve his or her goals.
- **Satisfaction:** How the user feels about his use of the system.

These definitions are widely cited. However, the ISO 9241-11:1998 arguably has superseded that of Shackel (1991) and is, therefore, used throughout the remainder of this article.

Definitions of a Conceptual Model

The word *model* implies an abstraction of the subject matter, or artefact, being modeled. This is true whether that artefact is an ICT system, a motorcycle, or a house. Inevitably, a model lacks the full detail present within an actual artefact, so, in producing the model, some properties of the artefact will be ignored or simplified. The particular abstraction will depend on the (intended) use of the model (e.g., a technical drawing of a motorcycle used in its manufacture abstracts different properties from that of an artist's sketch used in a sales brochure). Similarly, a usability engineer may model only those properties of an ICT system concerned with its interface, while a technical architect might model in terms useful to coding the system. In both cases, the subject matter is common, yet the abstractions and resulting models are very different.

The word *conceptual* stems from the word *concept*. This also implies some form of abstraction and, hence, a model. In psychology-oriented fields, this term may be used synonymously with the word *idea* and, therefore, has connotations relating to cognition, perception, innovation, and, most importantly, models stored in the *mind*. Alternatively, in (product) design-oriented fields, a *conceptual model* is more likely to be interpreted as an abstraction concerned only with the key or fundamental properties of an artefact (i.e., a model considerably lacking detail). Further, such models typically are expressed in concrete terms (e.g., a designer's sketch, clay model, or engineer's prototype).

The HCI domain incorporates principles related to both psychology and (product) design (an ICT system is a product). Similarly, both of the two (overlapping) definitions of a conceptual model presented have relevance here.

Mental Models

More in keeping with a (product) design-oriented view of conceptual models, we might define and express the conceptual model of an ICT system in concrete terms, using devices such as storyboards and Entity Relationship Diagrams (ERDs). However, these conceptual models only can be utilized once inside our minds (i.e., once converted into a *mental model*). Indeed, most cognitive scientists agree that our entire perception of the world, including ourselves, is constructed from models within our minds. Further, we only can interact with the world through these mental models. This is an insight