



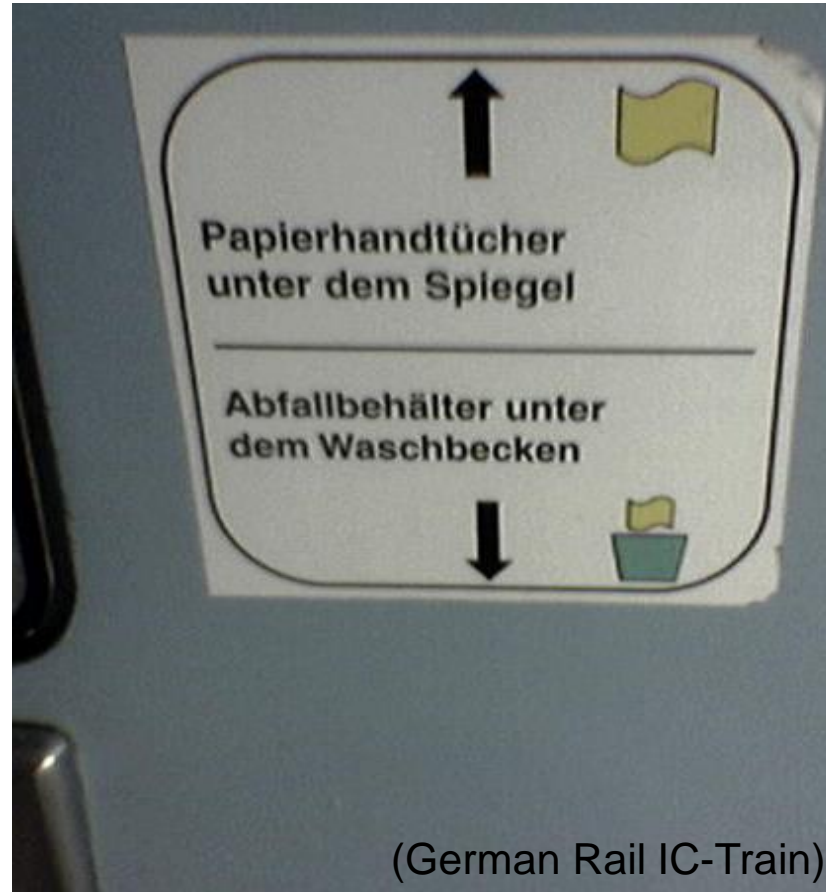
# Mental Modal and Metaphors

# Learning Goals

- Understand ...
  - Why it is hard for developers to spot usability issues.
  - How mental model, conceptual model, and metaphor relate
- Be able to explain
  - the terms mental and conceptual model,
  - The difference between mental and conceptual model,
  - what metaphors are, why they are useful, and where their limitations are.

# Why is Something Easy to Use?

Signs and explanations for things that are usually obvious are an indicator for a potential design problem.



(German Rail IC-Train)

# What is a Mental Model

## How the user thinks it works

‘In human-computer interaction research, the notion of **"mental models"** has come to be a very general catch-phrase for **anything having to do with end users' knowledge** of an application (van der Veer, 1990). There is a feeling that **if we could "capture" mental models, then we could build good interfaces [...]** But many [...] are much less convinced of the alleged benefits of mental models and of our ability to use them for reasoning or other complex cognition. [...] Researchers who have investigated mental images have been struck by how **incomplete and inflexible they are...**’

Nardi, B. A., & Zарmer, C. L. (1993). Beyond models and metaphors: Visual formalisms in user interface design. *Journal of Visual Languages & Computing*, 4(1), 5-33.



### Beyond Models and Metaphors: Visual Formalisms in User Interface Design

Bonnie A. Nardi, Craig L. Zарmer  
Software and Systems Laboratory  
HPL-90-149  
September, 1990

models; metaphors; visual formalisms; user interface design

The user interface has both syntactic functions - supplying commands and arguments to programs - and semantic functions - visually presenting application semantics and supporting problem solving cognition. In this paper we argue that though both functions are important, it is time to devote more resources to the problems of the *semantic* interface. Complex problem solving activities, e.g. for design and analysis tasks, benefit from clear visualizations of application semantics in the user interface. Designing the semantic interface requires computational building blocks capable of representing and visually presenting application semantics in a clear, precise way. We argue that neither mental models nor metaphors provide a basis for designing and implementing such building blocks, but that *visual formalisms* do. We compare the benefits of mental models, metaphors and visual formalisms as the basis for designing the user interface, with particular attention to the practical solutions each provides to application developers. We describe our implementation of a visual formalism to show the potential for visual formalisms to serve as reusable computational structures that support the development of semantically rich applications.

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# Mental Model

## How the user reasons and understands

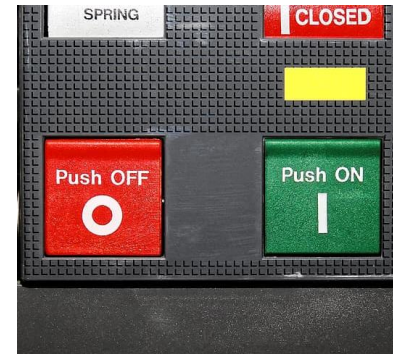
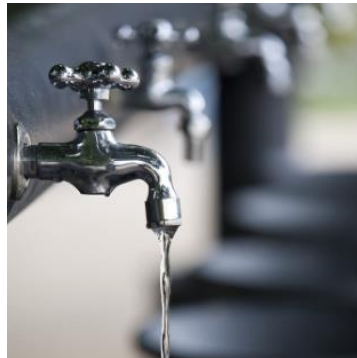
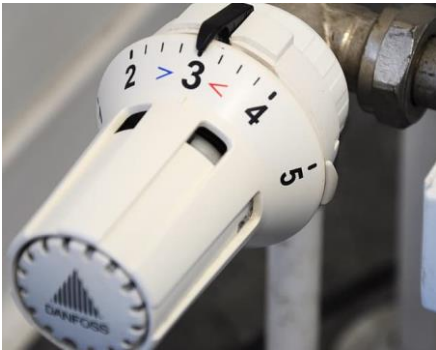
- Kenneth Craik (1943) ‘the mind constructs "small-scale models" of reality that it uses to anticipate events, to reason, and to underlie explanation’
- Users acquire mental models by
  - Interaction / observation
  - Explanation
- Two types
  - Functional – users know what to do, but not why
  - Structural – users know why to do something

William Hudson. Mental Models, Metaphor and Design (2003).UK UPA and HCI2003  
<http://www.syntagm.co.uk/design/articles/mmmad.pdf>

# Mental Model

## Example: Central Heating

- You came back and it is only 15°C in your room. You want a room temperature of 21°C. What do you do?
  1. You put the thermostat to 21°C and wait
  2. You put the thermostat to max (=35°) and switch it back to 21° once it is warm?
- What different mental models do people have who chose strategy 1 or 2?



William Hudson. Mental Models, Metaphor and Design (2003).UK UPA and HCI2003  
<http://www.syntagm.co.uk/design/articles/mmmad.pdf>

# Mental Model

## Definition by Jakob Nielsen

'A mental model is **what the user believes** about the system at hand.'

- 'A mental model is based on **belief, not facts**: that is, it's a model of what users know (or think they know) about a system such as your website. Hopefully, users' thinking is closely related to reality because they **base their predictions** about the system on their mental models and thus plan their future **actions** based on how that model predicts the appropriate course.'
- 'It's a **prime goal for designers** to make the user interface **communicate the system's basic nature** well enough that users form reasonably accurate (and thus useful) mental models.'

Jakob Nielsen. Mental Models on October 17, 2010  
<https://www.nngroup.com/articles/mental-models/>

# Mental Model

## Definition by Jakob Nielsen

- 'Individual users each have their own mental model. [...] different users might construct different mental models of the same user interface. Further, one of usability's big dilemmas is the common **gap between designers' and users' mental models**. Because designers know too much, they form wonderful mental models of their own creations..., leading them to believe that each feature is easy to understand. Users' mental models of the UI are likely to be somewhat more deficient, making it more likely for people to make mistakes and find the design much more difficult to use.

Jakob Nielsen. Mental Models on October 17, 2010  
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# Conceptual Model

## The model the designers wants the user to have

- “A conceptual model is a high-level description of how a system is organized and operates.”

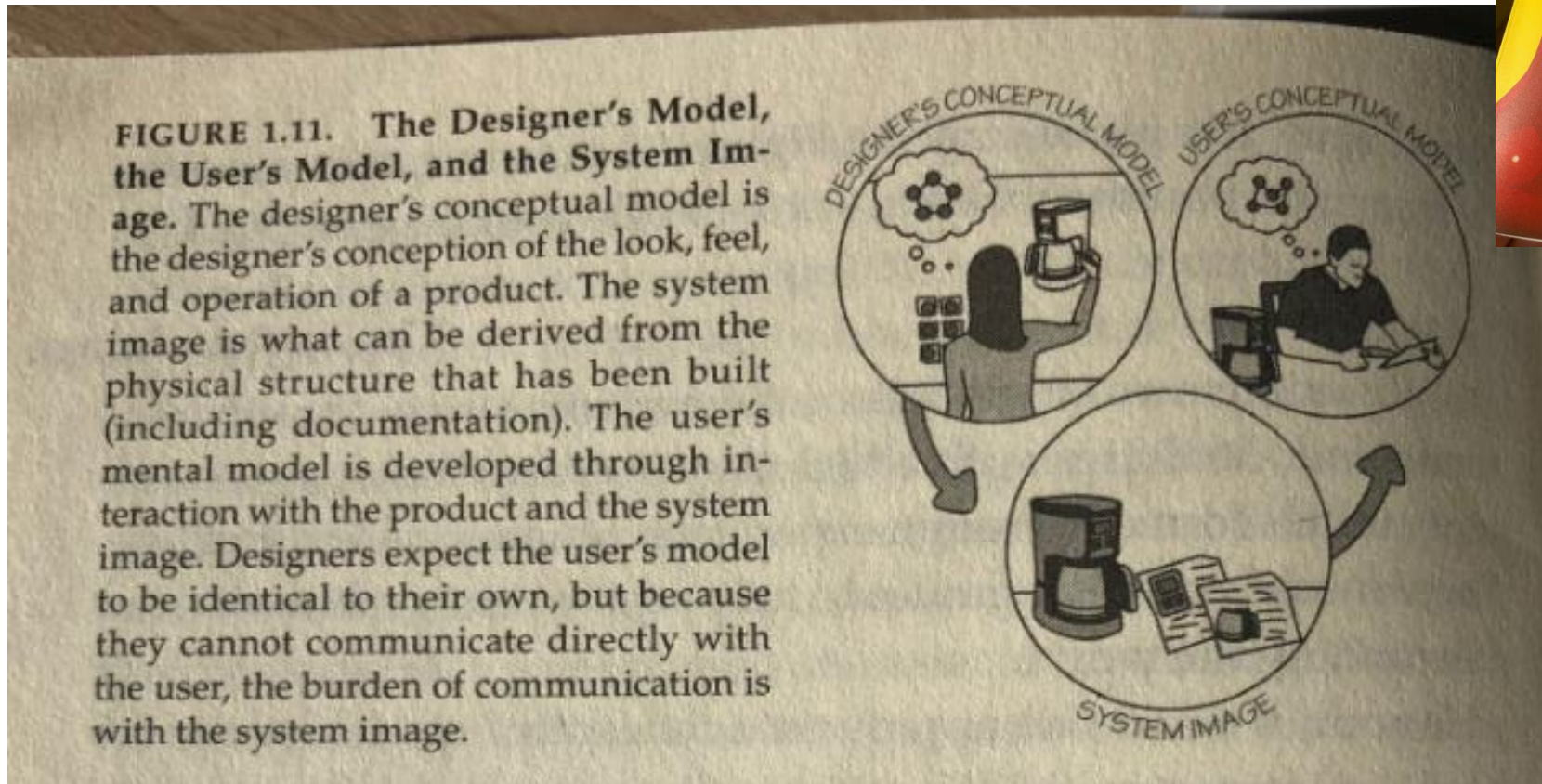
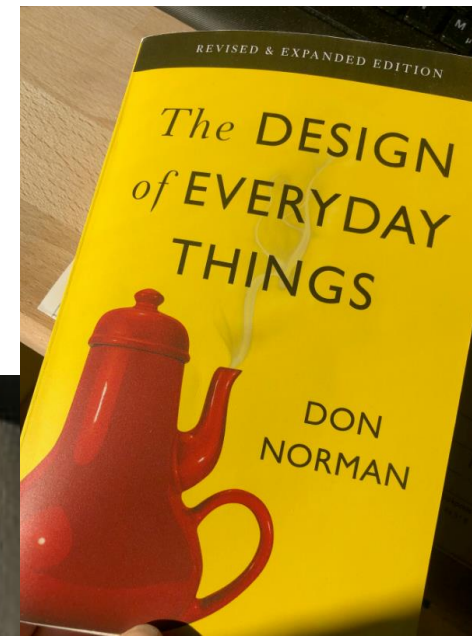
Johnson, J., & Henderson, A. (2002). Conceptual models: begin by designing what to design. *interactions*, 9(1), 25-32.

- The conceptual model
  - is deliberately designed
  - it allows to user to understand and operate the UI
  - it draws on prior knowledge of the user
  - is communicated through the interface and interaction design

William Hudson. Mental Models, Metaphor and Design (2003).UK UPA and HCI2003  
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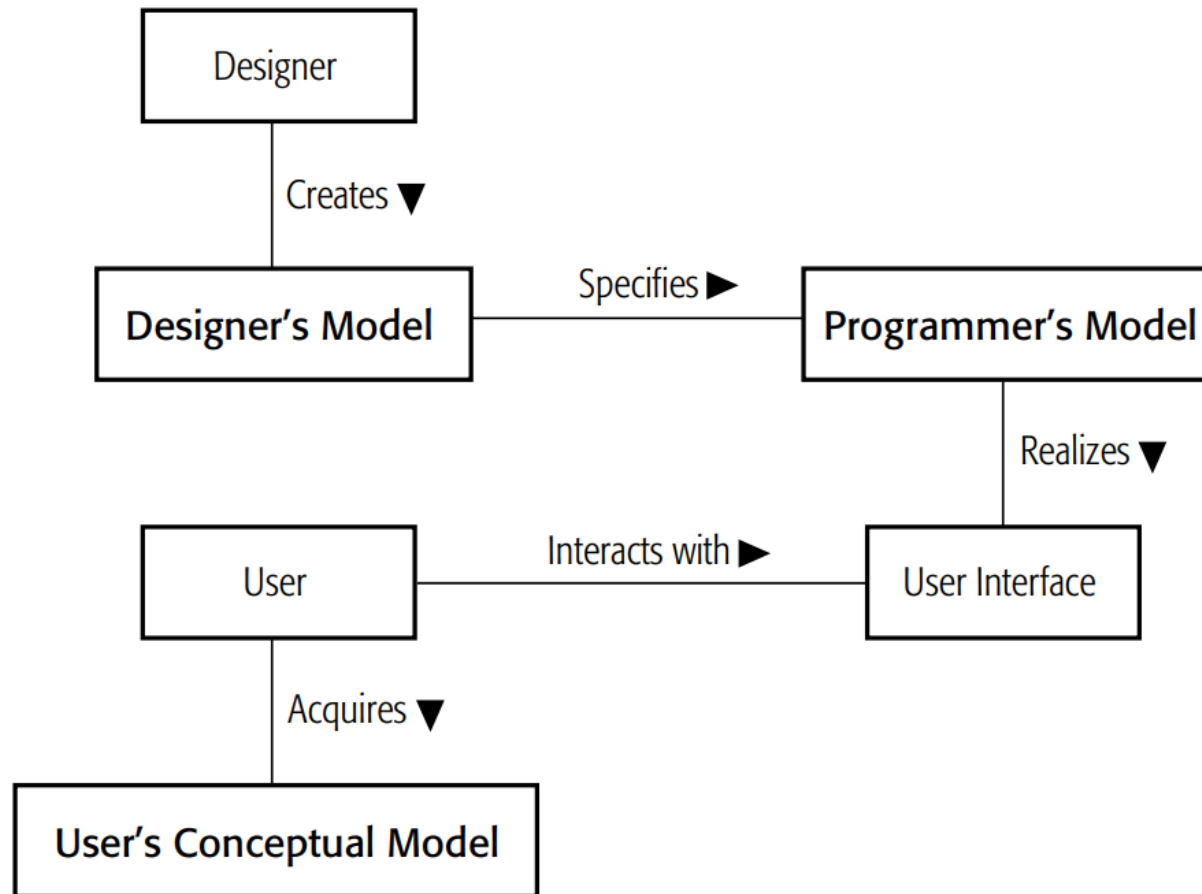
# Designer Model, User Model, and System Model

Don Norman



Norman, D. A. (2013). The design of everyday things: Revised and expanded edition. New York: Doubleday.

# Models – Designer, Programmer, User



Hudson, W. (2001). Toward unified models in user-centered and object-oriented design. Object Modeling and User Interface Design: Designing Interactive Systems, 313-362.

# Clarification of Terms

## Different things with the same intention

- **Mental Model** = User Model = User's Conceptual Model
- **Conceptual Model** = Designer Model
- **System Model** = Programmer's Conceptual Model = Programmer's Model = Implementation Model

# Metaphors

## Build on what the users know

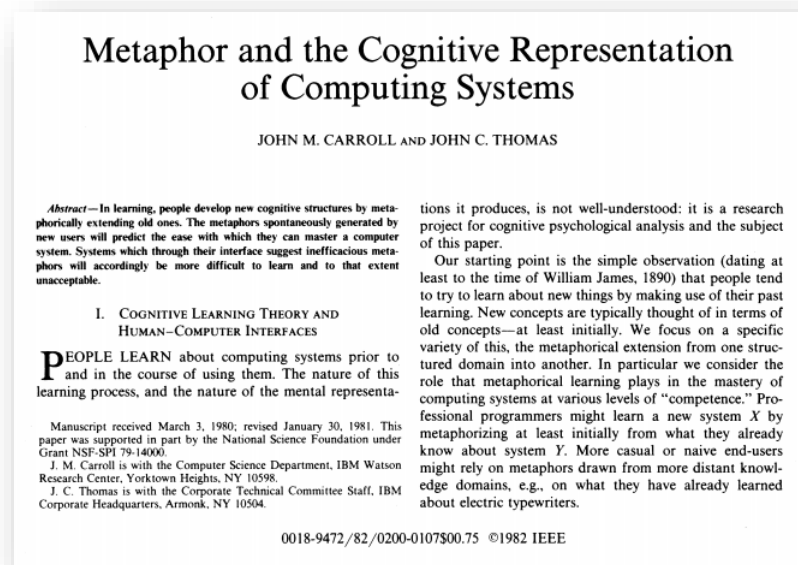
‘Given the analogy, the new **user can draw upon his knowledge about the familiar situation** in order to reason about the workings of the mysterious new computer system. For example, if the new user wants to **understand about how the computer file system works**, he need only **think about how an office filing cabinet works** and then carry over this same way of thinking to the computer file system’

Frank Halasz and Thomas P. Moran. 1982. Analogy considered harmful. In Proceedings of the 1982 Conference on Human Factors in Computing Systems (CHI '82). Association for Computing Machinery, New York, NY, USA, 383–386. DOI:<https://doi.org/10.1145/800049.801816>

# Metaphors

Build on what the users know

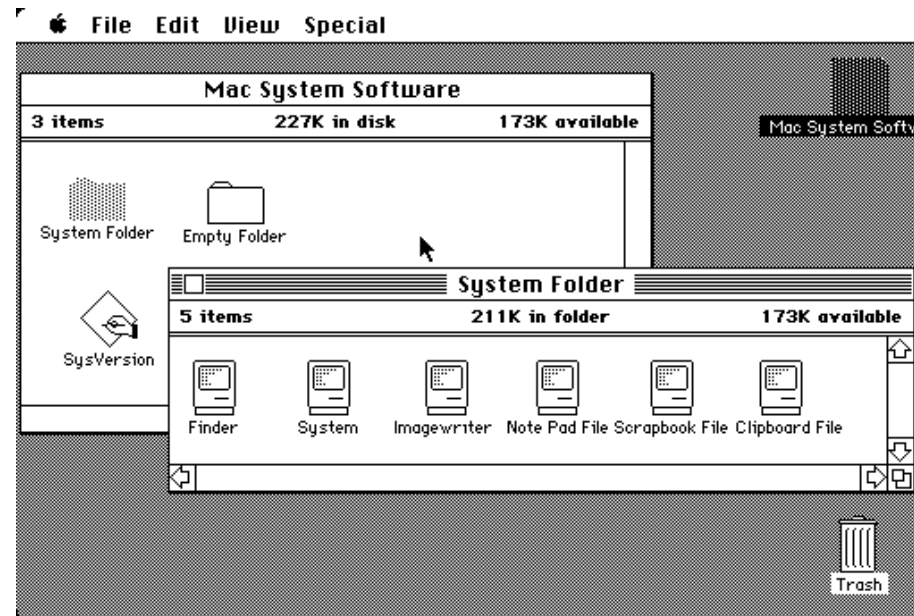
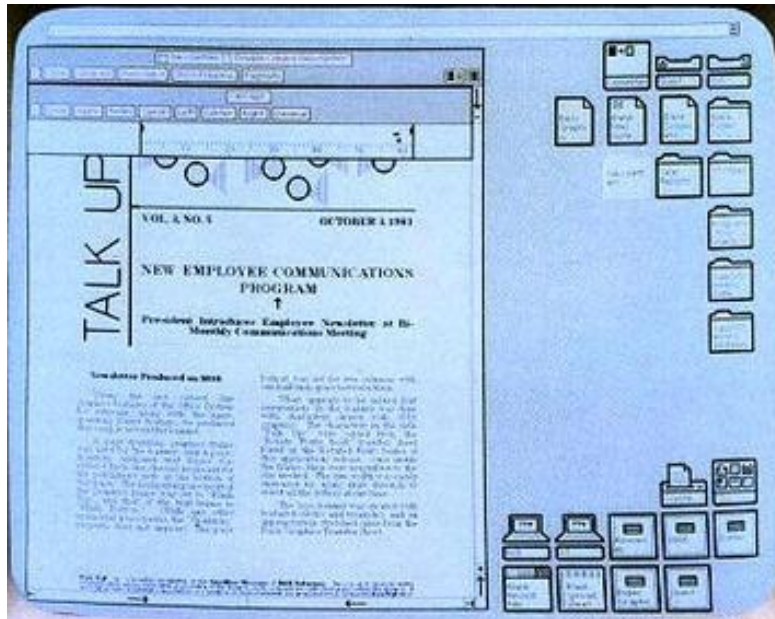
‘If people employ metaphors in learning about computing systems, the designers of those systems should anticipate and support likely **metaphorical constructions to increase the ease of learning and using the system.**’



Carroll, J. M., & Thomas, J. C. (1982). Metaphor and the cognitive representation of computing systems. *IEEE Transactions on systems, man, and cybernetics*, 12(2), 107-116.

# Metaphors - Examples

## Desktop Metaphor – Alan Kay at Xerox Parc



# Metaphors

... are also causing problems

‘However, metaphors suffer from numerous problems that make them unsuitable for expressing rich application semantics, and inappropriate for the reusable computational structures we seek. [...] Metaphors are slippery things, and not just because **they contain irrelevancies** (do we set the trash can out for garbage pick-up on Friday mornings?) and **incompletenesses** with respect to the domain they are meant to represent. [...] Metaphors tempt us to **over-generalize** and to forget distinctions that we should be remembering.’



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# Metaphors

## Mini Exercise

- Search for examples of user interface designs that draw on metaphors?
- Where do these metaphors work well?
- Where are they limited?
  
- A starting point for your search could be the early Book shelf app on iPads / iOS



# Did you understand this block?

Can you answer these questions?

- What is a mental model?
- What is the difference between functional and structural mental models?
- What is a conceptual model?
- What is the difference between a mental and a conceptual model?
- What are metaphors? What are their advantages and what are their limitations?

# References

- Nardi, B. A., & Zamer, C. L. (1993). Beyond models and metaphors: Visual formalisms in user interface design. *Journal of Visual Languages & Computing*, 4(1), 5-33.
- William Hudson. *Mental Models, Metaphor and Design* (2003). UK UPA and HCI2003. <http://www.syntagm.co.uk/design/articles/mmmad.pdf>
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