3012 / GC25 Interaction Design
Conceptual Design
Objectives of this unit

1. Know the different types of models which are relevant to the HCI design process.
2. Understand how
   - models influence users' interaction with the system
   - conceptual design aims to exploit this.
3. Appreciate problems with applying conceptual design approach.
The aim of conceptual design is to ensure that users construct an appropriate users’ models of the system by interacting with the system image (user interface, manuals, training etc.). The construction of the user's model is heavily influenced by the user’s previous knowledge and experience and the user’s task.

The system image must be based on a clear and concise design model

The design model must be based on the users’ task and their previous knowledge and experience. The design model is not a representation of the structure of the underlying system, but a model which will help users use the system effectively. A “normal” calculator, for example, does not reflect the internal stack structure in the user interface.

For the original paper on conceptual design, see Norman (1986)
### Models, models & more muddles

- user’s model/mental model
- design model/conceptual model
- system image
- user model
- metaphor
- analogy

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<table>
<thead>
<tr>
<th>Who Has model of</th>
<th>User</th>
<th>Designer</th>
<th>Researcher</th>
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<tr>
<td><strong>System</strong></td>
<td>UC User’s Model</td>
<td>DC Design Model</td>
<td>R(U) Conceptualisation of User’s Model</td>
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<tr>
<td><strong>User</strong></td>
<td>DU Designer’s Model of the User</td>
<td>RU Researcher’s Model of the User</td>
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<td><strong>Task</strong></td>
<td>UT User’s Model of Task</td>
<td>D(UT) Designer’s Model of User’s Task</td>
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<td><strong>World</strong></td>
<td>UW User’s Knowledge and Experience</td>
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Research in cognitive psychology:
- Gentner & Stevens (1983): role of models in teaching of science and engineering
- Johnson-Laird (1983): models in human inference (syllogistic reasoning)- human mind does not follow rules of formal logic (example: Wason-task experiment, which shows that people’s ability to solve problems that a formally equivalent (in terms of propositional logic) is better for concrete than abstract problems

Terminology: The term original term used in cognitive psychology was mental models. Unfortunately, the term has been applied to almost any type of model in HCI. To avoid confusion in HCI, the term user’s model is now widely used when referring to the user’s internalised representation of how the system works.

This should, however, not be confused with the term user model, which is model of user’s perceptual/cognitive processes or behaviour as represented in a computer program. They are often found in adaptive systems/UIs and computer-assisted learning packages, and are sometimes used for non-empirical evaluations of systems.
The idea of a conceptual model is quite closely linked with Norman & Draper’s (1986) User-Centred Design: the designer observes the user performing a task or evaluating a prototype and tries to come up with a “concept” for a design. This may be expressed in terms of a metaphor (a la desktop or rooms) or be more abstractly represented in a diagram or drawing. The designer will then use this concept to group system functionality and how it is selected/executed, and communicate that model through the user interface. The user will then form an appropriate mental model and user’s model through interaction with the system.

If this process is successful, the user will develop an appropriate user’s model of how the system works, and use the system successfully ... this is the fairy tale of conceptual design ... now read on for the dirty realistic version.
The system image is the only means that the designer has got of communicating the design model to the user. Furthermore, the designer cannot rely on all the potential aspects of the system image to be available. Most Internet applications like browsers and email applications, for example, are used without users receiving any training or reading any user documentation. In those situations, the only part of the system image that users interact with is the actual screen display (reflecting system behaviour) and the built-in help system.
The idea of conceptual design a la Norman & Draper is that the designer builds the system on the basis of the conceptual model, which is communicated through the system image. If this process is successful, the user will develop an appropriate user’s model of how the system works, and use the system successfully ... this is the fairy tale of conceptual design ... now read on for the dirty realistic version.

"Users will add to what is so clearly communicated on the display every past experience that they have had, relevant or not. If the interface carries any trace of ambiguity, the user will find it out and jump to the wrong conclusion. In short, the user will insist on doing everything wrong, wrong, wrong!"

(Tognazzini 1992)
Conceptual design is easier said than done!
The problem is that conceptual design is a high level description of a design method, which so far isn’t supported by adequate tools for carrying out the actual design process.

However, conceptual design is being used, and design guidelines are being provided and developed.

Newman and Lamming, e.g. provide many practical methods

Robert et al. (1998) present a method called OVID, and object oriented approach developed at IBM for developing the design model and system image. Unfortunately, OVID does not cover actual screen design.
How useful are user’s models?

- Users will construct models, whether the designer aims for this or not
- Trying to direct model-building process is worthwhile - but can’t assume the intended model will result.
- We can try to cue/exploit existing models (user tasks, related systems).
- Metaphors can be used for this purpose …

* If construction of a certain user’s model is the explicit goal of a design exercise, evaluation needs to be performed to check whether users are actually employing those models. We will look at methods for doing this in the second lecture on CD.
Metaphors from the office world are pervasive in office automation systems today. The question is: how faithfully should the electronic office emulate the real one?

"The desktop metaphor ... is an inviting metaphor that provides easy access to the system. Once users are emerged in the desktop metaphor, users can adapt readily to loose connections with physical situations - the metaphor need not to be taken to its logical extremes."

(Apple Human Interface Guidelines, 1987)
The advantage of metaphors, apart from users actually liking interface metaphors, is that they provide a scaffold for users to construct their users’ models by cueing existing knowledge structures which can be utilised in explaining the design model to users.

The disadvantages of metaphors are that:

- the functionality of the system may be restricted to fit a chosen metaphors, i.e. novel functionality may be left out of the system because it does not exist in the metaphor.
- the metaphor may suggest functionality which is not implemented in the system (this is called conceptual baggage - see next slide).

Representing differences between the metaphor and design model is therefore important, but hardly ever done.

For the above reasons, using metaphors as design models is rarely a good idea. But using metaphors as part of the design model can work very well - as long as it is clearly communicated in the system image which parts of the metaphor are implemented and which are not. Functionality belonging to the design model which is not covered by the metaphor must be communicated clearly as well.

### Metaphor

- existing model from a different domain which has similar structure to intended user’s model
- exploit user’s existing knowledge and experience to construct appropriate user’s model
- facilitate access and encourage exploration
According to Andersen et al. (1994), in order for a metaphor to work, it must not have too much conceptual baggage (V+S⁻), i.e. a high proportion of features that do not apply to the system compared to the amount of features that the metaphor and system have in common. The conceptual baggage suggests functionality which does not exist in the system.

This problem was also described in a case study by Lundell & Anderson (1995). They describe the problems finding a suitable metaphor for what is now known as the “front panel” - the Unix equivalent to the desktop metaphor:

“... the design team came up with a number of alternate metaphors: the desk organizer, a briefcase, a stereo panel, a remote control, etc. These all had interesting attributes, but all had too many undesirable properties.”

Erikson (in the Baecker book) gives a list of heuristics for evaluating metaphors:

1. How much structure does metaphor provide?
2. How much of the structure is relevant to problem?
3. Is the metaphor easy to represent?
4. Will intended users understand the metaphor?
5. Can it be extended?

The next unit give an example of how useful metaphors can be as conceptual models.
Example: Evaluate the “Recycle Bin” metaphor.
Metaphors in our minds are cued by language and/or visual clues. Maintaining the structural similarity, which facilitated the use of a particular metaphor in the first place, as well as the language and visual clues which the target user population associate with a certain metaphor, is important.

Cultural issues have to be considered. Certain metaphors have different symbols and vocabulary associated with them depending on culture. See for example the Internet bookstore Amazon whose U.S. site (http://www.amazon.com) differs subtly from their site in the UK (http://www.amazon.co.uk).
Example 1: SDR

- Method: informal talks with local users and questionnaire emailed to remote users
- We identified: What users use SDR for and how often
- We found: two potential metaphors
  - Radio Times
  - Yellow Pages
- We chose: *Electronic Radio times*
  (Electronic TV and radio listings guide)

SDR is a multicast session directory tool for announcing and joining sessions (broadcasts and interactive videoconferences) on the Mbone (real-time multimedia part of the Internet). Information about multicast conferencing and user guides to SDR and other multicast conferencing tools can be found under

http://www-mice.cs.ucl.ac.uk/multimedia/software

A more detailed paper (Clark & Sasse, 1997) can be found on the course web page.
Example 2: Burglar Alarm

- Problem
  - alarms too difficult to use; users don’t arm them
  - occupied buildings are strongest deterrent
- Analogy - car central locking
- Design model: central locking plus Home Aware
- System image
  - simple: how to alarm
  - friendly (non-technical)

More about this design case study at http://www.designcouncil.org.uk/betterbydesign/security/projects.html
There is now a general consensus in the HCI community that user performance cannot be taken as proof that users have a certain model (or not). Users may do the right thing for the wrong reason, and vice versa. Also, Payne et al. (1990) found that users are often not at all confident about what they are doing, even if they are choosing the right action.

Another important point is that research has shown that the system image itself does not form part of the user's model - even highly competent users cannot spell out a sequence of steps unless they have the system in front of them (Payne et al., 1992).

Users' models are best elicited by users working through real tasks and verbalising what they are trying to do. This can be highly artificial, so the best strategy is to make verbalising part of the task, i.e making the user communicate with another user (constructive interaction - Miyake, 1986)
CD in practice

- CD process is an idea; there is currently not much tool support
- We can draw on traditional HCI methods (task analysis, user studies) around, but need to be integrated in CD process.
- Detailed evaluation methods can help to track users’ models.
- This can become part of a “Conceptual Designer’s Toolbox”
Contemporary legends or urban folklore are stories which are perpetuated but are not true; they express commonly held fears, which can indicate lack of knowledge/understanding.
CD Toolbox (2)

(4) Constructing design model
- extend or merge metaphors or analogies
- structural model (as opposed to procedural model)
- creative design methods

(5) Implementing Design model in System Image
- Linguistic, structural and visual consistency
- Interviews, scenarios, conceptual maps
- Grounded theory (ID concepts, relationships, structures)

(6) Evaluation
- verbal protocols
- drawings
- constructive interaction, teach back
Summary points

1) Users form internal representations of (mental models) of systems they interact with.
2) An appropriate model facilitates user system interaction, an inappropriate one is likely to impair it.
3) Models can be communicated through UI (appearance and behaviour) and training, but “fit” with users’ existing knowledge and experience is crucial.
4) Metaphors may be used as basis of design model.


