Introduction to HCI

Mental and Conceptual Models

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Today

- Discussion of readings [10 min]
- Mental models [40 min]
  - Conceptual models
  - Conceptual design
- In class activity [20 min]
  - Conceptual design

Discussion on requirement readings [10 min]

- Discuss with your team the following questions [3 min]
  - What you learned?
  - What surprised you?
  - How can you use this knowledge in your project?

- A randomly assigned team will present results to the class [7 min]

Why look at cognition?

Part of doing good design is understanding how people **reason** and **react to** interface experiences

Cognitive frameworks: help us do this!

- theories of cognition provide **predictive** and **explanatory** power for understanding user behaviour

- Internal frameworks:
  - the mental process inside users head
- External frameworks:
  - interactions with technologies, environment, context

Mental models

- "In interacting with the environment, with others, and with the artifacts of technology, people form internal, mental models of themselves and of the things with which they are interacting. ”

  -Norman (in gentner & stevens, 1983)

- People use their mental models to:
  - Reason about a system
    - How to interact with it; how it works
  - Figure out what to do when things go wrong

Mental models vs. Conceptual models/design

- Mental models: *something the **user has (forms)***
  - Users "**see**" the system through mental models
  - Users **rely** on mental models during usage
  - There are various **forms** of mental models
  - Mental models can **support** users' interaction
- Conceptual models and conceptual design
  - This is what the **designer** does, to foster good mental model formation by the user.

Introduction to Conceptual Models

https://www.youtube.com/watch?v=pAOyWFOFhsg

The Designer's Model, the User's Model, and the System Image

the **user** also has a **mental model**. they don't necessarily match.

Recall our design concepts:

the basics:
(elements of these in many of the others)

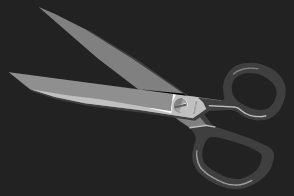
- affordance
- signifiers
- mapping
- constraints
- feedback

other concepts:

- findability
- transfer effects
- cultural associations
- individual differences

→ all inform a user' mental model

An object that helps you form a mental model: scissors

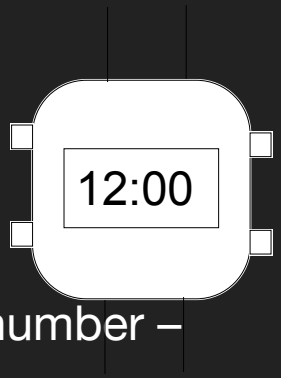


- Affordances:
  - Holes for something to be inserted
- Constraints:
  - Big hole for several fingers, small hole for thumb
- Mapping:
  - Holes-for-fingers suggested / constrained by appearance
- Positive transfer and cultural idioms
  - Learnt when young; constant mechanism
- Mental model:
  - Physical object implies how the operating parts work

A reasonable mental model can be formed by just looking at and perhaps holding the object.

- Some things you don't understand you do anyway: why big blade down?

An object that **hinders** mental model formation: "old style" digital watch

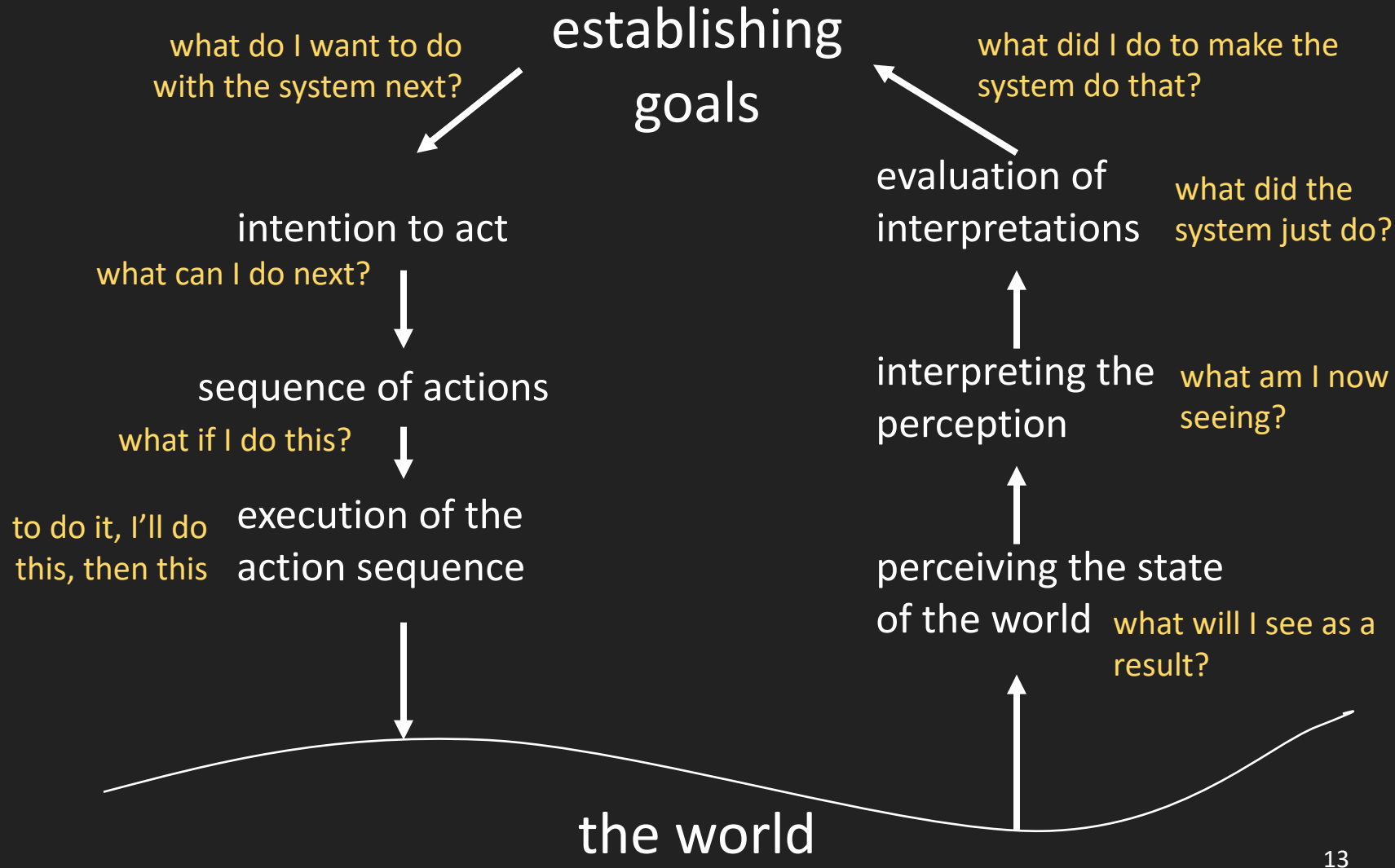


- Affordances - mixed:
  - Four buttons are clearly for pushing and the screen shows a number – but unclear what the *entire object* affords
    telling time? Setting alarms, timers, viewing heartrate, other data?
- Visibility – lousy:
  - What will happen if you push each button? What mode is watch in?
- Constraints and mapping - unknown:
  - No visible relation between buttons, possible actions and end result
- Transfer of training:
  - Little relation to analog watches. But, maybe from other digital devices.
- Cultural idiom:
  - Some standardized core controls and functions but others variable
- Mental model:
  - Must be taught, or learned by trial/error

Norman's seven-stage model

- https://www.coursera.org/lecture/uva-darden-running-design-sprints/usability-with-donald-normans-7-steps-model-8dFEC

What mental models tell the **user**



Norman's seven-stage model
what is it good for?

- Internal framework: best for exploratory learning
  - But this is just one way to form a mental model of a system
- Less applicable to highly learned, semiautomatic behavior
  - User has already developed strong expectation of what will happen/how it will happen
  - Gulfs in these cases tend to be very small (scissors example)

Acquiring mental models

- During system usage:
  - The user's own activity leads to a mental model
  - Explanatory theory, developed by the user
  - Often used to predict future behavior of the system
- Observing others using the system:
  - Casual observation of others working
  - Asking someone else to "do this for me"
  - Formal training sessions
- Reading about a system
  - Documentation, help screens

- This is done **by the user** (not the designer)

Some characteristics of mental models

- Incomplete
- Constantly evolving
- Not accurate representation
  - (contain errors and uncertainty measures)
- Provide a simple representation of a complex phenomena
- Can be represented by a set of if-then-else rules

Conceptual Models & Conceptual Design

Conceptual models & conceptual design:

- Conceptual models describe how an interactive system is organized
  - The user also has a mental model. They don't necessarily match.
- Conceptual model = the foundation of the interface.
  - Different user interfaces could be built upon it
  - There are many ways to represent a conceptual model
- Goal of conceptual design, how do conceptual models fit?
- Interface design translates the cm into things we can see and interact with. It involves design choices, but must stay faithful to the concepts and terminology of the CM.

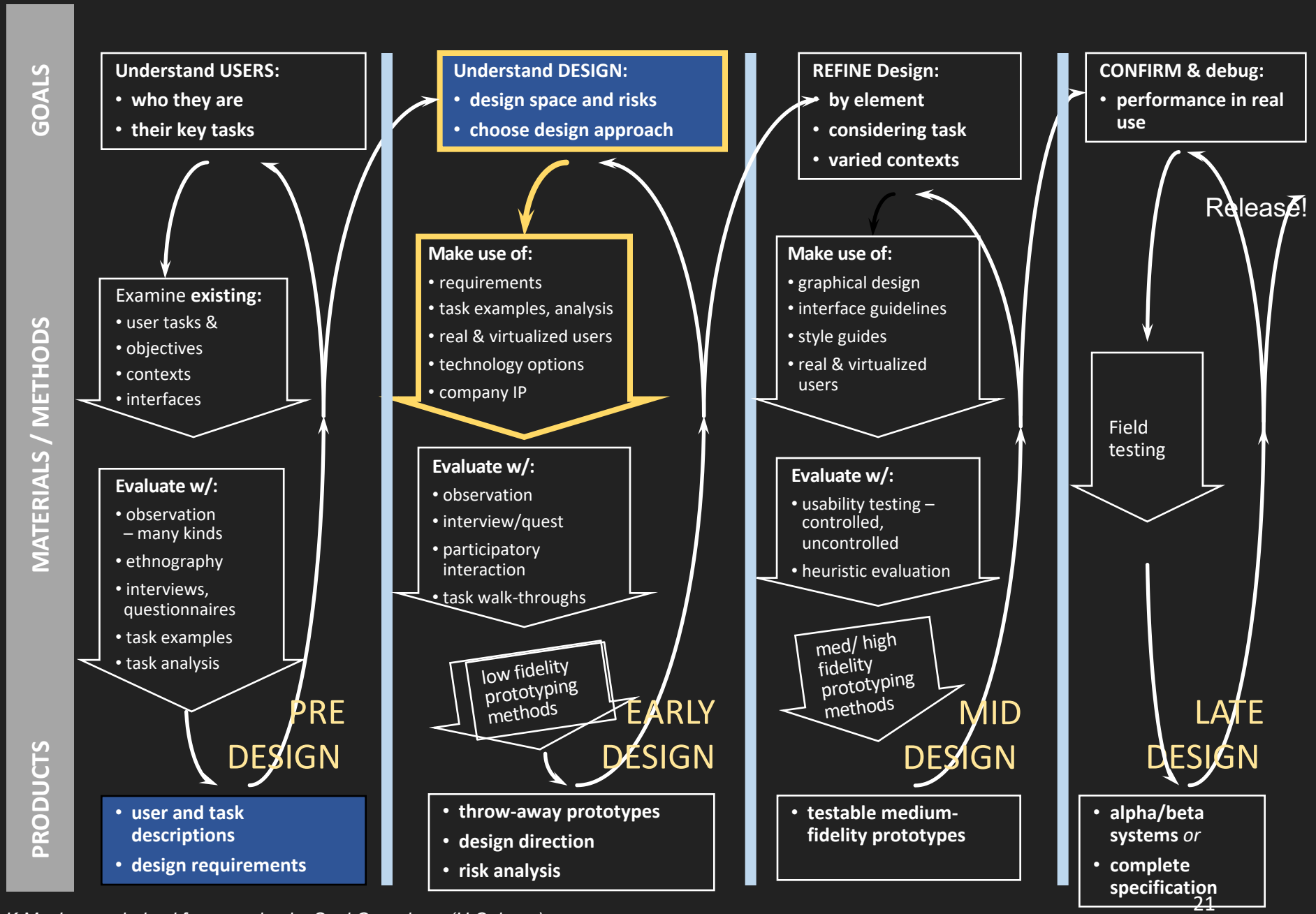
What is conceptual design?

- Crossing the gap from **requirements** to a **solution**
- Starts with brainstorming; multiple iterations to narrow down
- A conceptual design
  - Can take many different forms
  - Be built through many approaches
  - Is essentially a **set of ideas**

Mental models vs. conceptual models

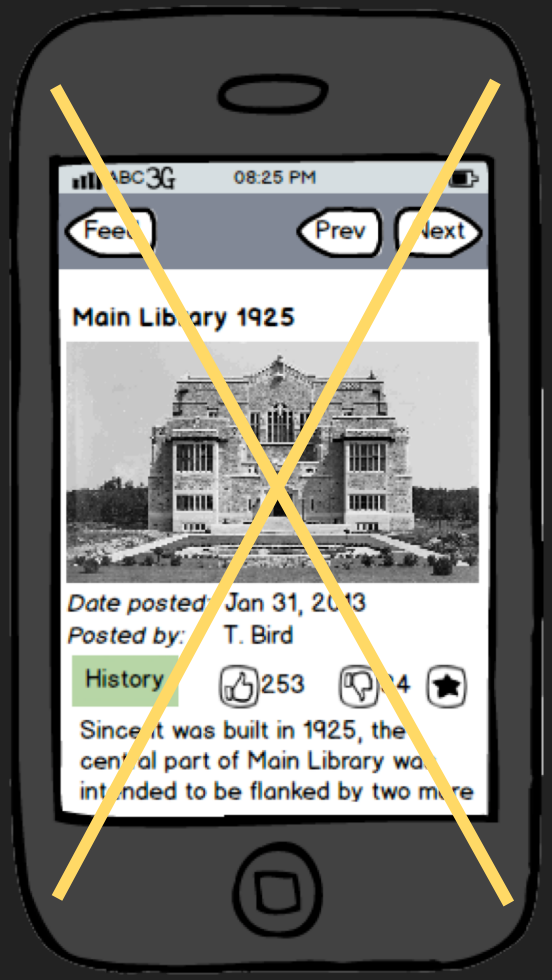
- Mental models: *something the user has (forms)*
  - Users "**see**" the system through their own mental models
  - Users **rely** on mental models during usage
  - There are various **forms** of mental models
  - Mental models can **support** or **impede** users' interaction
- Conceptual models: *articulation of designer's (i.E. Your) mental model*
  - What users **will be able to do**
  - What **concepts or knowledge** users will need, in order to interact
  - **How they will** interact with system (at a very high level)

Big Picture – WHEN do task examples and requirements happen?



A conceptual model **excludes**

- Low level presentation
- Implementation details
- Menu and screen designs
- Widgets
- Etc.



if you started here,
you will probably get into trouble

A conceptual model can include:

- Any central design **metaphors** and analogies
  e.G. The “desktop metaphor”
- **Concepts –** objects, actions you can do to them; user roles; attributes of both.
  E.G., Files and folders; both can be opened, have names;
- **Relationships** among concepts
  e.G., Files are *contained* in folders
- **Mappings** from concepts to the user experience envisioned**;**
  e.G., The users can *browse* files, and *mark favorites*
- **Terminology** that will be used (consistently) to tie it all together
- **Interaction** types; how will they interact with it?
  E.G. Give commands, perform operations, explore
- **Interface** types; is it/should it be constrained? How would different interfaces affect result?

Metaphors

- Well known concepts you can rely on to help users understand and interact with the system

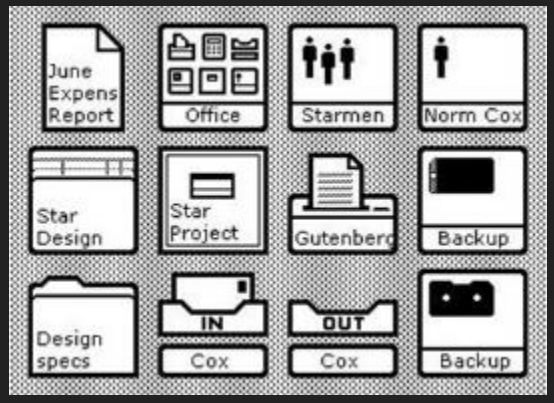
- Many kinds, e.g.,
- Interactions
  - Swipe to turn page in an ebook
  - Move backwards through time to explore file backups

- Ecological, contextual, broader system structure, e.g.
  - Dropbox: a box you drop everything into
  - Icloud: central mother ship to which everything connects

- Personal relationships, e.g.,
  - Siri as a personal assistant

Example: the desktop metaphor

•Unifying set of concepts employed in graphical user interfaces to help users understand and easily interact with a computer



- Computer monitor → user's desktop

•Objects → documents, folders
you can do things with these objects:

- Place documents upon desktop
- Open documents into a window → paper copy
- Organize in folders

- Extend desktop with desk accessories → calculator, notepad

Relationship among concepts

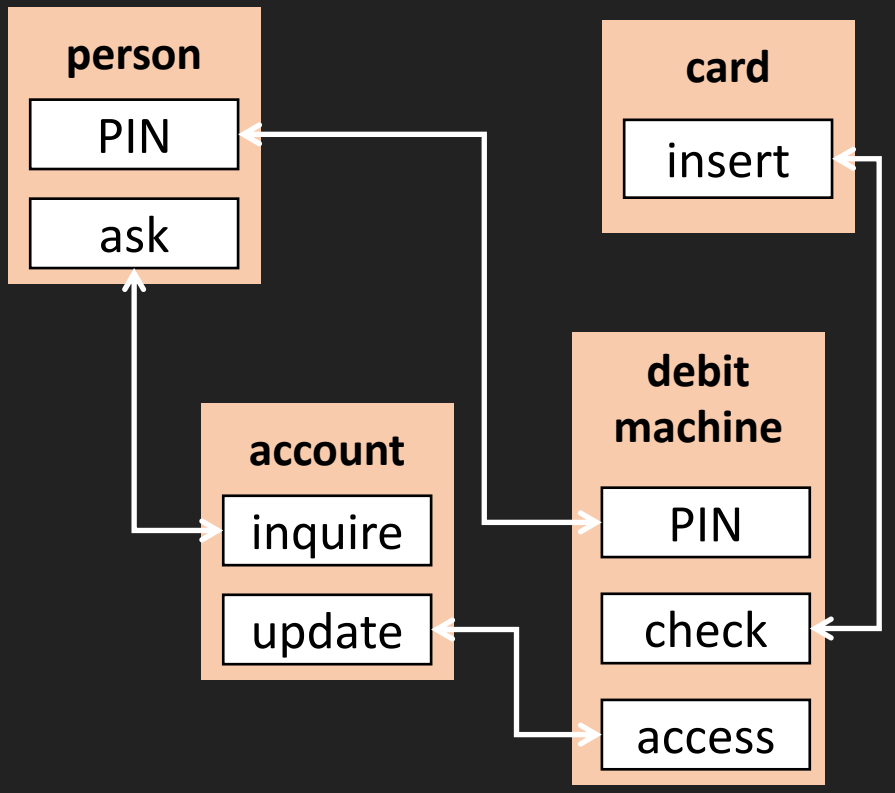
- What actions or attributes are shared between objects?
  - E.g. Song, podcast, audiobook all have timelines that users want to navigate (i.e. Fast forward, rewind, etc.)

- Containment and hierarchy
  - E.g., A song is contained by an album

MAPPING of concepts to actual activities

How do the concepts **map** to what people will actually do?

- One easy way to tell:
  "run" a task example on it
- Learn:
  - Are these the right objects?
  - Can i do all the operations?
  - Do they match what people want to do?
  - Can i do them in a consistent way?



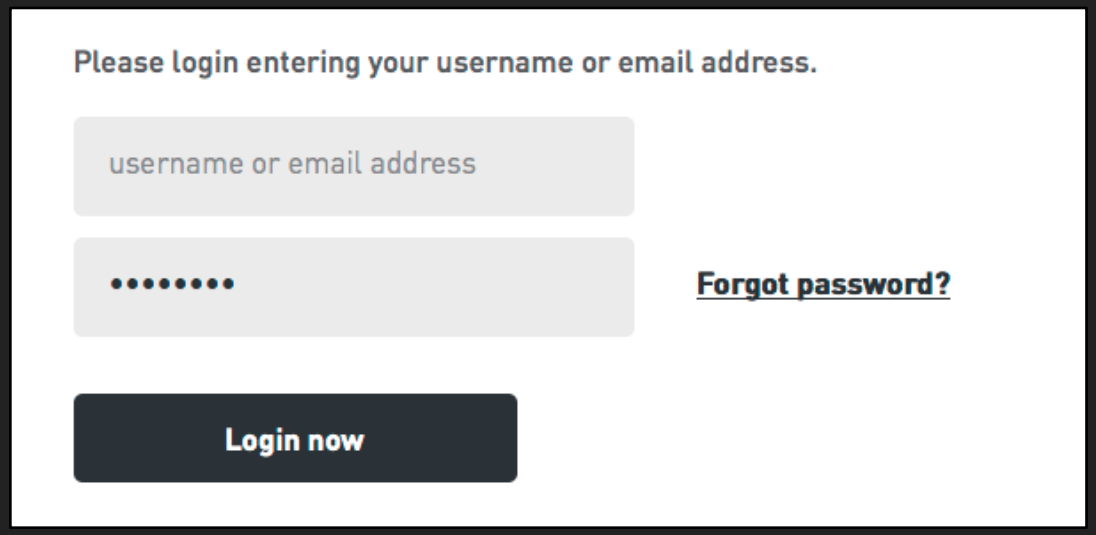
example: debit machine

TERMINOLOGY

What terms will you use to communicate concepts?

- Terminology should match your concepts
- Choose your terminology and stick to it!

Easy to go from planning to interface and minimize confusion



- Does your user login to a system with a user-id? A username? A member id? Or an email address?

Conceptual models: interaction and interface

- Interaction type:
- What the user is doing when interacting with a system.
  - E.G., Command line (how you talk to it), intelligent (function), gestural (hardware), touch (both hardware and interaction type)
- Interface type:
- The kind of interface used to support the mode.
  - E.G. Speech, menu-based, gesture

Interaction types

- Instructing
- Instruct a system and tell it what to do; issuing commands and selecting options (e.g. Print a file, save a file)
- Conversing
- Interacting with a system as if having a conversation (e.g. Search engines, advice-giving systems, help systems, virtual agents)
- Manipulating
- Interacting with objects in a virtual or physical space by manipulating them (e.g. Dragging, selecting, opening, closing and zooming actions on virtual objects)
- Exploring
- Moving through a virtual environment or a physical space (e.G. Google maps, GPS)

INTERFACE TYPES

- Many different kinds (we won't examine each in detail)
  - Includes: mobile, GUI, touch, tangible, haptic, desktop, command line, data visualizations…

Interface type	See also
1. Command-based	
2. WIMP and GUI	
3. Multimedia	WIMP and web
4. Virtual reality	Augmented and mixed reality
5. Information visualization	Multimedia
6. Web	Mobile and multimedia
7. Consumer electronics and appliances	Mobile
8. Mobile	Augmented and mixed reality
9. Speech	
10. Pen	Shareable, touch
11. Touch	Shareable, air-based gesture
12. Air-based gesture	Tangible
13. Haptic	Multimodal
14. Multimodal	Speech, pen, touch, gesture, and haptic
15. Shareable	Touch
16. Tangible	
17. Augmented and mixed reality	Virtual reality
18. Wearable	
19. Robotic	
20. Brain–computer	

What does a conceptual model look like?

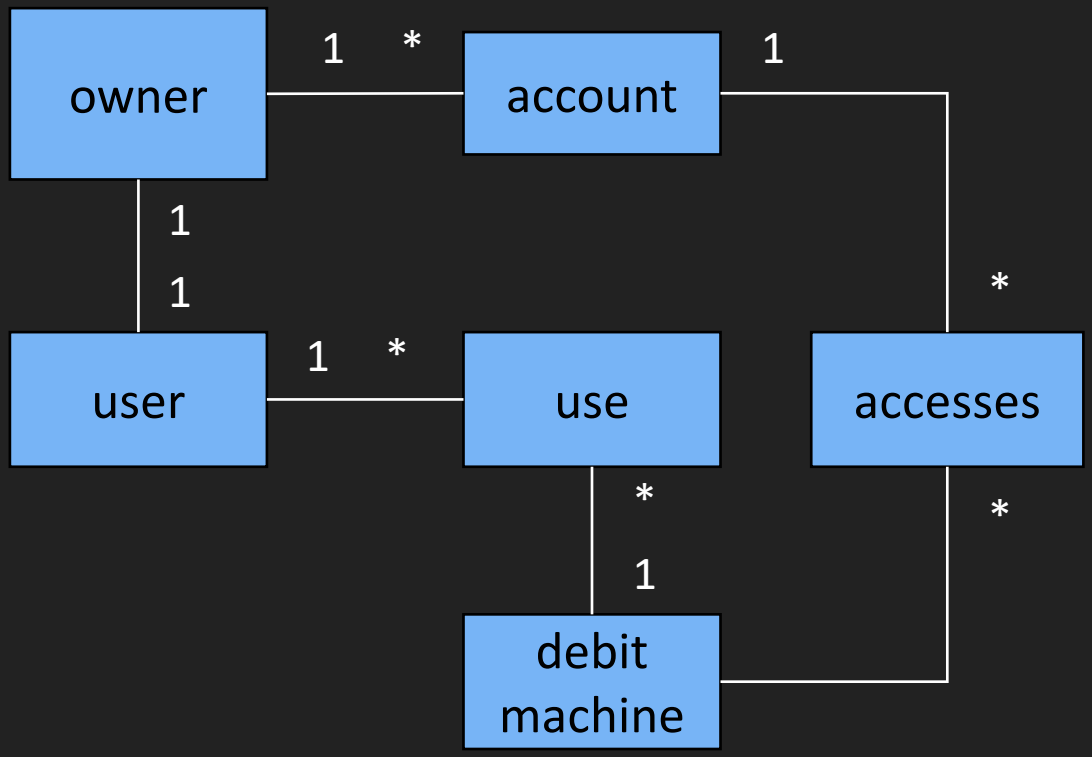
- However best helps you describe and understand its components:
  - Lists and tables
  - Diagrams
  - Storyboards and sketches
  - Written descriptions
  - Mood boards
  - Physical ‘sketches’

Different methods might capture different parts of more effectively than others

➔ you’ll likely use a combination of more than one!

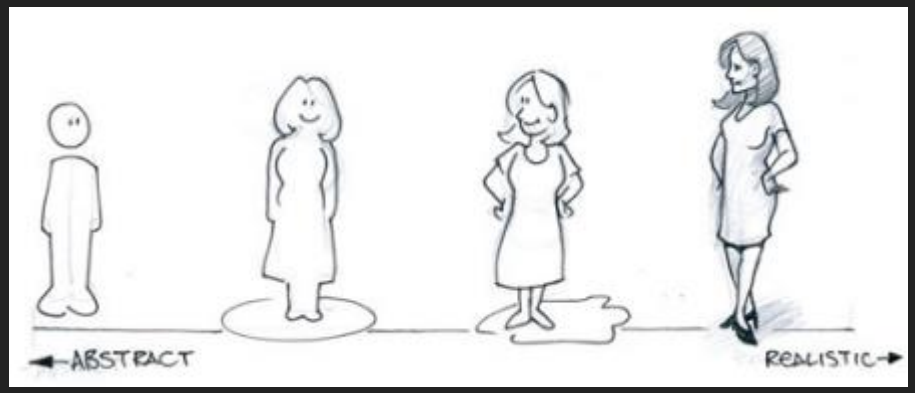
Conceptual model for a debit machine

- *Using a diagrammatic approach*
- shows concepts, relationships, terminology



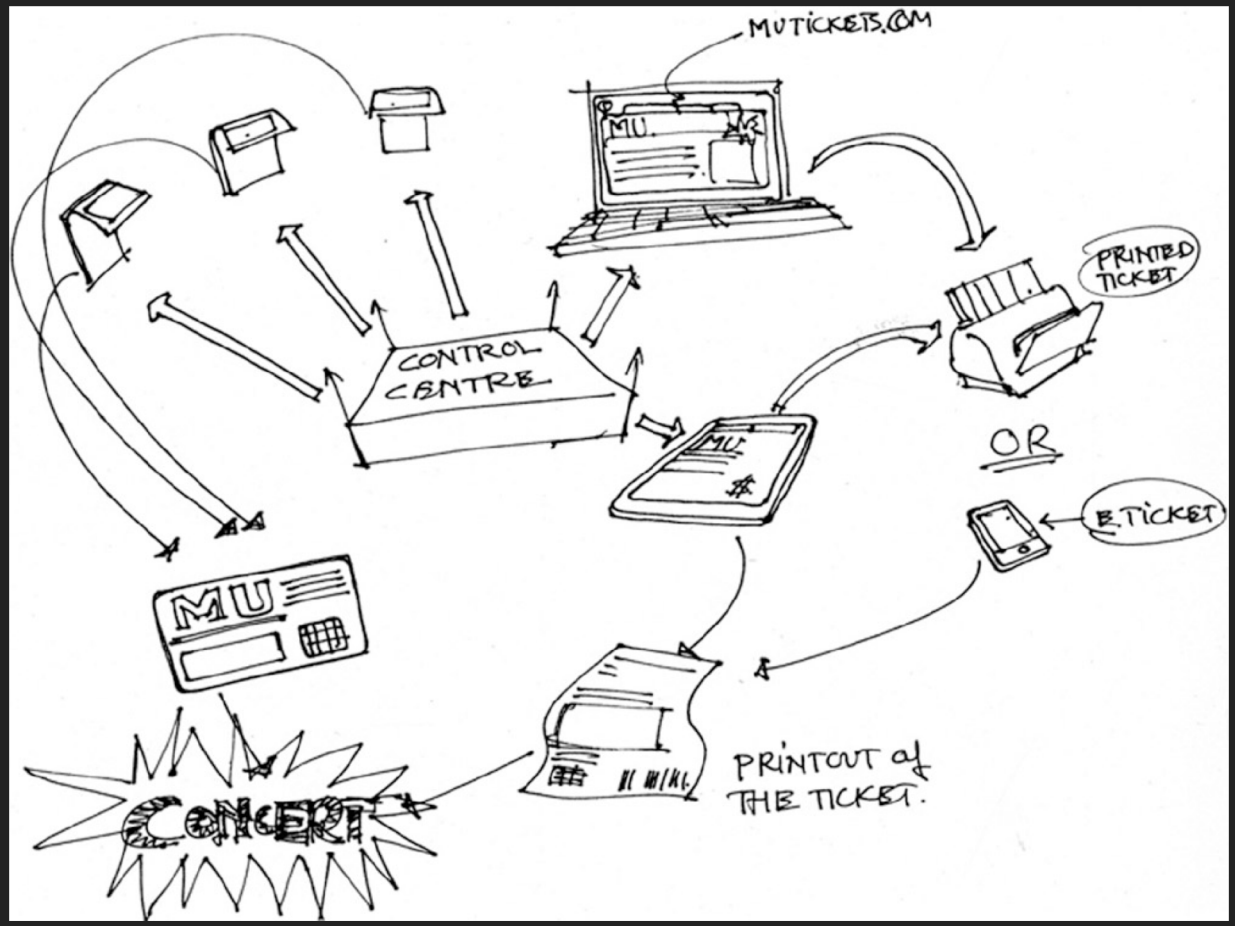
Storyboards and sketching

- Flexible methods for representing conceptual design!
  - Can be used to show what the user is thinking/feeling
  - Communicate metaphors
  - Interface types and styles of interaction
  - Environments and contexts in which system is used
- Can be very low investment
- Note: you don't need to be good at drawing to communicate your ideas
    - Sketches and storyboards can vary in fidelity



Ben Crothers. *Storyboarding & UX –Part 2: Creating your own*. Oct 17, 2011

This conceptual design representation emphasizes
objects and relationships for an e-ticket system

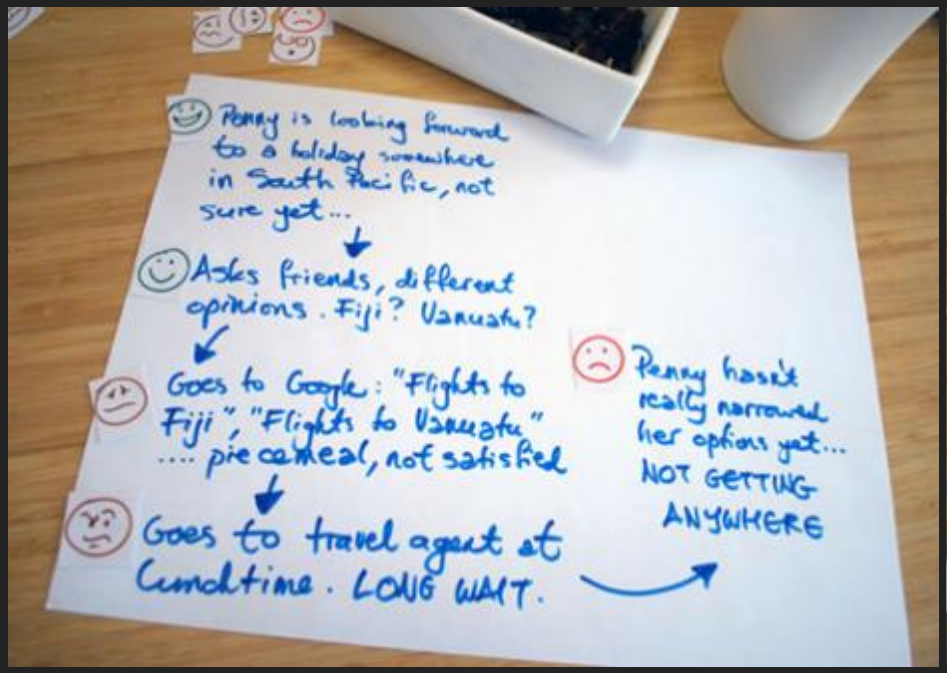


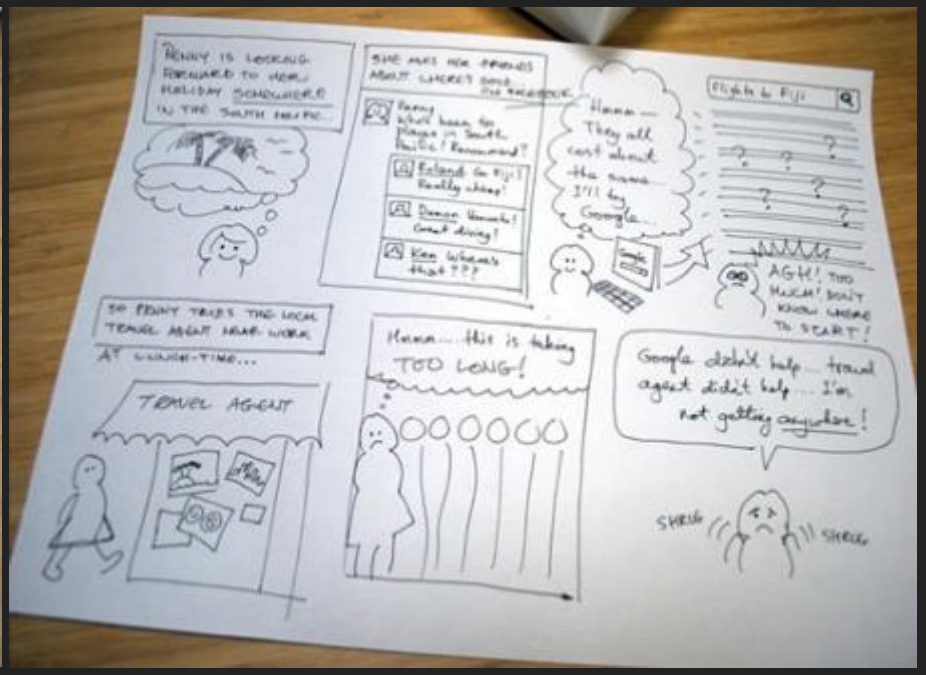
Akshay Sharma, Virginia Tech Department of Industrial Design from The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson and Pardha S. Pyla

Storyboards

Guidelines for storyboards:

- Decide what you want trying to communicate
- Consider *characters, plot*, *environment, user's thought process and emotions*
- Iterate: start with text and arrows & move up to more involved drawings





Ben Crothers. *Storyboarding & UX – Part 2: Creating your own*. Oct 17, 2011.

Summary:
a good conceptual model:

- Must make sense
  e.g., Metaphors that build on something the user knows, and translates well
- Has to be consistent
  e.g., In terminology, in how objects are interacted with.
- Has a minimal set of concepts
  keep it simple as possible; conceptual model will be apparent to user if they can see all of it
- Focuses on elements of task user wants to do

- *Need to settle on it early in the process*

Activity [20 min]

Check the website for the worksheet

Scenario: imagine: you've been hired to (eventually) build a new user web interface for reserving rooms in the UMass CS department.

Task: Create a visual representation(s) of a conceptual model based on your brainstorming

On deck…

- Next class is not going to be a working class, check the website for the updated schadule…
  - Readings (as posted)

- Second project milestone: Ideate
  - due on Oct 15th

Extra slides

System design vs. Interface design?

- System designers and implementers may have more concepts or details going on in the background
- But conceptual model (and eventually interface) should only contain what users need
- System concepts should only be included when they can foster a good mental model

Identifying concepts: object / operation analysis

- Method from johnson and henderson

➔What are all the ‘concepts’ that a user will need in the system?

➔Implication: should be what people use to interact with the interface!

Include: all objects, attributes, operations of tasks that users need to be aware of or understand to use system

- User-understandable entity types (objects, people, …?)
- Attributes of each entity-type
- Operations that users can perform on each type of object
- Note where these concepts may be different for different users

Task examples are a great resource for these!

identifying concepts: example:

objects	attributes	operations
songs	album, title, artist, descriptions, currently playing, # times played date added to system	play, preview, pause, stop, rewind, fast forward, add to play list, send to a friend
album	title, artist, description, compilation, currently playing, # times played, date added to system	play, stop, add to play list, send to a friend
playlist	title, description, date created, # times played	play, stop, skip song, choose song, send to a friend
user profile	username, favorite albums, favorite songs, credit card #,	review songs, review albums,

Interaction types

1. Instructing

instruct a system and tell it what to do; issuing commands and selecting options (e.g. tell the time, print a file, save a file)

2. Conversing

interacting with a system as if having a conversation (e.g. search engines, advice-giving systems, help systems, virtual agents)

3. Manipulating

interacting with objects in a virtual or physical space by manipulating them (e.g. dragging, selecting, opening, closing and zooming actions on virtual objects)

4. Exploring

moving through a virtual environment or a physical space (e.g. google maps)

1. Instructing

- Use when:
  - User needs to **tell system** what to do
    *RSP defines as **indirect** (as opposed to 'direct manipulation')*
- Common conceptual model:
  - Word processors (open, close, save, etc.)
  - Vcrs/dvd players (play, rewind, pause, etc.)
- Benefit: supports quick and efficient operations
  - Good for repetitive actions on more than one object
  - Must be aware of the possibilities – learned

2. Conversing

- Use when:
  User needs have a dialogue, i.E. Back-and-forth.
  - Really a dialogue, not just a series of options and selections.
  - More of a 2-way conversation than in **instructing**
- Examples: often implemented with natural language
  - Many online help centers (have you ever been fooled?)
  - Siri (can also be instructing)
  - Edge case: typing queries into a web search engine
  - *Compare with:* kiosk operation like buying a bus ticket
- Benefit: when/WHY to use?
  - Good for novices, the computer phobic, specialized applications, etc.

3. Manipulating

- Use when:
  - Makes sense to *directly manipulate objects*
  - Benefit: leverages what people *do in the real world*; (e.G., Drag/drop)
  - But CAN be used for non-realistic actions too (e.G., Zoom)
- Principles:
  - Representation is always available (visible)
  - Incremental, reversible actions (“undo”)
  - Physical actions (drag/drop) rather than syntactic commands
- Examples of tasks that could use “manipulating”
  - File operations (open, close, save)
  - Moving selected block of text around on a powerpoint slide
  - Touch interaction with maps (pinch, zoom, slide)

4. Exploring

- Use when:
  - User needs to explore and interact with an ‘environment’.
  - Can exploit user’s previous knowledge of how they move through spaces (digital and physical)

- Examples of tasks that could use “exploring”
  - Finding a location in google maps:
    using street view
  - Identify location using ‘dot’ on GPS:
    physically move through actual environment with phone

Interaction types

- Instructing, manipulating most common historically; but conversing and exploring increasingly used

- Not exclusive
  - You can do multiple within one interface for DIFFERENT objects
  - Or for the SAME objects, e.G.,
    ➔ Instructing AND manipulating of files (open, close, save, etc.)
    ➔ Instructing and conversing for help functions
    ➔ Conversing AND exploring for following GPS directions