Properties of People

(as they impact interaction technique design, implementation and use)
Administration

• Assignment #6 set today
Three Main Issues

• Mental Models

• Performance Characteristics of People

• Errors

• Cover again some past material
  – Some topics that are really important
  – Tie together some concepts that may seem separate
  – Think about these as we go through lecture
The “interface cycle”

- Evaluates & understands display
The “interface cycle”

- Evaluates & understands display
- Formulates goals & actions
The “interface cycle”

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- Formulates goals & actions
- Acts to produce inputs
The “interface cycle”

USER
- Evaluates & understands display
- Formulates goals & actions
- Acts to produce inputs

SYSTEM
- Interprets input events

Input Devices

Display
The “interface cycle”

USER
• Evaluates & understands display
• Formulates goals & actions
• Acts to produce inputs

Display

SYSTEM
• Updates internal “state”
• Interprets input events

Input Devices
The “interface cycle”

**USER**
- Evaluates & understands display
- Formulates goals & actions
- Acts to produce inputs

**SYSTEM**
- Updates display
- Updates internal “state”
- Interprets input events

**Display**

**Input Devices**
Norman’s “Gulfs”

- Norman describes 2 user activities as bridging
  - The Gulf of evaluation

![Diagram showing User and System]

User

System
Norman’s “Gulfs”

- Norman describes 2 user activities as bridging
  - The Gulf of evaluation
  - The Gulf of execution

- Making these “gulfs” (mappings) small makes the interface much easier to use
Mental models

• To evaluate and act, people inevitably build models of how the system works
  – can’t help but do it
  – may be highly detailed and functional
  – may be quite naïve

• Generally are not complete, not necessarily “logical”, …
Model of mental models
(from Gerhard Fischer, U of Colo.)

What the system designer thinks the system does
Model of mental models

What the system designer thinks the system does

What the system actually does
Model of mental models

Frequently Used (Well understood)
Part of System Functionality
Model of mental models

Occasionally Used Part of System Functionality
Model of mental models

User’s full model of what the system does
Key points about mental models

What happens here is very important
Key points about mental models

• The system designer has too good a mental model
  – Nearly perfect mental model
  – Really good prediction of what system does
  – Real user’s can’t ever have that good a model
UI Design Guideline

A system implementor cannot pretend to be a user
You know too much
You can’t forget

→ HCI Mantra:
  “The user is not like me!”
Design is only part of the process

• Design is important
  – Get close to real thing
  – Right conceptual framework, etc.

• But only part of overall process
  – Can’t get it completely right *a priori*
    • Just too hard
  – Need overall iterative process
    • *i.e.* the full HCI process
Good User Interfaces

• A user interface is good if:
  1) It offers (convenient access to) the functionality needed to perform the task efficiently
  2) The user’s mental model accurately predicts interface action
Good User Interfaces

• From traditional CS point of view
  1) is fine: “design in the right things”
  2) is a big problem
     – Good UI is not a function of the software!
     – Good UI is (mostly) a property of the user!
Good UI is a property of the user

• On a per user basis
• We don’t even have control over much of this
  – e.g., baggage from existing mental models
• Aaaargh!
  – But this is reality
How do we deal with this?

• Carefully and explicitly structure our designs to try to induce the right mental model in the user
  – and test that it does!
  – and fix it when it doesn’t (full process)
• Have explicit “conceptual model”
  – view of what mental model we are trying to give
Principle:

- People can’t form very good mental models of things they can’t see
Two specific things to worry about

• Affordance

• Feedback
Affordance

• Opportunities to act which are readily apparent to the user
  – Form “affords” certain actions and makes that apparent
  – Allows and promotes certain actions
    • Door knobs afford turning
    • Handle of hammer affords grasping in a particular way
Affordance

• Example: Knurling
  – Small ridges typically found on knobs

• Increases friction => Affords grip
“Virtual affordances”

- Don’t typically have much physical form in a GUI

- But, visual appearance can still suggest function
“Virtual affordances”

• Don’t typically have much physical form in a GUI

Note that you don’t have to know about knurling for this to afford “grip” with the mouse

• Reminders of the real world work
Two specific things to worry about

• Affordance

• Feedback
Feedback

• Response by the system to the actions of the user
  – Cause and effect
  – Essential for forming mental models

• Making “system state” visible
UI design guideline

• Explicitly design a conceptual model and use
  – affordance
  – feedback

• (and everything else you have) to reinforce it
Performance properties of people (as related to interaction)

• (Only a few here)

• How long will things take?
  – e.g., physical movements

• How much can people remember?

• How fast are thing perceived?
How long will user actions take

• Strong models for physical movement

• Again: Fitts’ law predicts movements as a function of distance and required accuracy:

\[ T = A \log_2(D/S + 0.5) + B \]
How much can a person remember

• Short term (working) memory
  – Famous $7 \pm 2$ “chunks”
    (Somewhat outdated model)
  – For us just: “very limited”

• Long term
  – Essentially unbounded
  – But requires effort and may not always work on cue
  – Can’t explicitly forget!
How much can a person remember

• Implication:
  Generally better to rely on recognition (seeing it in front of you) than just recall (having to pull it out of long term memory)

• Novice / expert differences
How fast are things perceived?

- $< \sim 20 \text{ms (1/50 sec)}$ discrete images/flashes merge into continuous perception
  - Image you are looking at flickers 60 times per second
  - Differences in peripheral vision across users
How fast are things perceived?

- < ~20ms (1/50 sec)
- Displays update at 50-75hz
- Don’t ever have to be faster than this for user response!
How fast are things perceived?

- $< \sim 100\text{ms}$ seems like "instant response"
  - Hard to tell response times below this apart
How fast are things perceived?

• 100ms (1/10 sec)
• Except some animation, most things don’t need to be faster than this
How fast are things perceived?

• < 1-2 seconds typically “good response time”
  – Similar times in conversational turn taking protocols
  – Longer delays ~5 sec have to say something to keep conversation alive

(Note: numbers fuzzier as we go out)
How fast are things perceived?

- > 10-15 sec is typically “bad response time”
  - STM decay effects
A little about response times

• Good vs. bad response time is very dependent on expectation
  – If you can’t meet the goals, manipulate user expectations!

• Consistency of response is very important
  – Can be more important than time
Advice/Guideline (from Donald Knuth):

- Premature optimization is the root of all evil
  - Build it and refine usability first
  - Only optimize if usability tests say you have to
  - CS intuitions about this misleading
How long do other cognitive activities take?

• Unfortunate, but...
  – Not as well understood
  – Much harder to apply what is understood
  – See other HCI courses for some of this
We do know essentially minimums

- “Cycle” times for “Human Processor”
  - Perception, Processing, and Motor cycles
  - Ballpark: ~100-200ms each
- Can be used to predict reaction times and highly routine actions
  - E.g., it takes at least ~250ms to act on something
- Harder to use for complex things and/or with learning
Final property of people: Errors

- People make lots of mistakes!
  - A fundamental property of people
    - Lots of errors
    - Everyone
    - All the time

- If you are designing for real people then...
UI design guideline

• Errors are not exceptional events!
  – Part of the expected and normal
  – Despite nomenclature
  – System has to be designed from the bottom up to deal with errors at least as effectively as other actions

• Sharp contrast to how I was taught to program
Handling errors is critical to mental model formation
• How do people learn?
Handling errors is critical to mental model formation

• How do people learn:
  – Read the manual
    (not if they can help it!)
Handling errors is critical to mental model formation

• How do people learn:
  – Read the manual
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  – Get help from friend / expert
    (more likely, but expensive)
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• Explore!
Handling errors is critical to mental model formation

Does this make things better or worse!??
Undo and errors

• Perceived danger of straying outside known strongly affects willingness to explore
  – Hence ability to learn

• Various forms of undo have a major effect
Summary UI design guidelines

• Pay attention to:
  – Affordance
  – Feedback
  – Performance
  – Likely errors
Questions?