HUMAN ABILITIES

...and their implications for design
Today

• Re-cap for Assignment 2f and final report [10m]
  – sketches, storyboards, scenarios
• Re-cap design principles (cont’d from Tue) [30m]
• Human abilities [40m]
• Q&A about assignments [10m]
## Calendar

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<td><strong>WEEK 4</strong></td>
<td><strong>Design principles</strong>&lt;br&gt;10:30 - 11:50&lt;br&gt;EEB 045&lt;br&gt;2e - Task Review</td>
<td><strong>Human Performance</strong>&lt;br&gt;10:30 - 11:50&lt;br&gt;EEB 045</td>
<td><strong>Sections</strong>&lt;br&gt;10:30 - 11:20&lt;br&gt;MGH 287&lt;br&gt;1:30 - 2:20&lt;br&gt;MGH 254&lt;br&gt;2f - Design Check-in</td>
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<td><strong>Maya Office Hour</strong>&lt;br&gt;1:30 - 2:30&lt;br&gt;CSE 542</td>
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<td><strong>Reading1: Research Paper</strong>&lt;br&gt;Maya Office Hour&lt;br&gt;1:30 - 2:30&lt;br&gt;CSE 542</td>
<td><strong>Paper prototyping</strong>&lt;br&gt;10:30 - 11:50&lt;br&gt;EEB 045&lt;br&gt;2g - Getting the Right Design Report</td>
<td></td>
<td><strong>Presentations</strong>&lt;br&gt;10:30 - 11:50&lt;br&gt;EEB 045</td>
<td><strong>Presentations</strong>&lt;br&gt;10:30 - 11:20&lt;br&gt;MGH 287&lt;br&gt;1:30 - 2:20&lt;br&gt;MGH 254</td>
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Assignment 2f: Design check-in

• Revise the tasks (if needed)
• Brainstorm three designs, describe and sketch
  – Should be significantly different
Design sketches

Communicating ideas visually
Design sketches

Include only what is required to render the intended purpose or concept
Design sketches

Highlight relevant functionality

Show relations between different sketches
Design sketch example 1

Figure 1: Tracking Liquid Intake Over Time

Figure 2: Finding Motivation for Proper Hydration

Figure 3: Smart Beverage Suggestions

Figure 4: Convenient Reminders to Drink Water
Design sketch example 2
Design sketch example 3

Tracking Liquid Intake Over Time

Smart Reminder Setup
Storyboard

• You will do this for the final report, due next Tue.
• Can include some design details, but still focus is on the task.
Storyboard example 1
Storyboard example 2
Scenario example 1

Annie is a junior student at University of Washington lives in an apartment in U-district. Annie wakes up at 8:00 AM, and drinks some water from her Aqueous water bottle. The bottle then sends a data to her mobile app about what kind of liquid she drinks and the amount. On her way to school, Annie stops by a coffee shop and gets a cup of Latte for herself. Since Annie doesn’t want to pour the coffee to Aqueous bottle, she opens her Aqueous app and manually input her coffee drink for tracking. In the afternoon, Annie refills her bottle with orange juice. As she drinking the juice from the bottle, her phone app keeps tracking her beverage intake by data received from the bottle. Annie finishes her day in school, and she opens her Aqueous app as she is waiting for the bus. The app tells her that she has finished her liquid intake goal for today, and also shows a line chart of her weekly liquid intake.
Scenario example 2

Bob is a senior designer at Google. Bob starts working at 9:00AM with his design work. Bob has a Aqueous bottle with him at the office. Latter in the morning, the bottle turns red to remind Bob to drink some water. But Bob is too busy with his work, and just ignores the bottle. After three hours of working, it is 12:00 PM and Bob decides to get some lunch. Then, Bob’s phone is vibrating and sending him a reminder to remind him take some water during lunch break. Bob then realizes that he didn’t take any water for morning, and grabs his bottle to drink water.
DESIGN PRINCIPLES...continued
Design principles
Don Norman, Design of Everyday Things.
Fundamental concepts/principles

• Conceptual/mental models
• Affordances
• Signifiers
• Mappings
• Feedback
• Constraints
Conceptual models are mental representation of how something works.
Affordances

• Jointly determined by:
  – qualities of the object
  – abilities of the agent

• They exist even if they are not visible

Handles afford pulling
Affordances
Affordances

Perceptual Information

<table>
<thead>
<tr>
<th>Perceptual Information</th>
<th>Affordance</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>False Affordance</td>
</tr>
<tr>
<td>yes</td>
<td>Perceptible Affordance</td>
</tr>
<tr>
<td>no</td>
<td>Correct Rejection</td>
</tr>
<tr>
<td>no</td>
<td>Hidden Affordance</td>
</tr>
</tbody>
</table>

signifiers
Signifiers *new!*

• Affordances determine what actions are possible
• Signifiers *communicate* what actions are possible and where/how the action should take place
  – Touch displays: which parts can be touched, tapped, slid up/down/sides...
Signifiers

©copyright Don Norman
Mappings

© copyright Don Norman
Feedback
Feedback
Feedback

1. Set both controls
2. Allow 24 hours to stabilize
Feedback

• We are very sensitive to contingency
Feedback

• We are very sensitive to contingency
Feedback

• Beeps
• Sounds
• Lights
• Progress bars
Feedback

• Beeps
• Sounds
• Lights
• Progress bars

Neilsen’s heuristics:
- Good error messages
- Visibility of system status
Everyday actions

Gulf of execution and evaluation

GOAL

How do I work this? What can I do?

What happened? Is this what I wanted?

WORLD

©copyright Don Norman
Everyday actions

Gulf of execution and evaluation

GOAL

How do I work this? What can I do?

What happened? Is this what I wanted?

WORLD

Bridge of execution and evaluation

GOAL

PLAN

COMPARE

SPECIFY

INTERPRET

PERFORM

PERCEIVE

WORLD

© copyright Don Norman
Everyday actions

Bridge of execution and evaluation

What do I want to accomplish?

What are alternatives?

What can I do?

How do I do it?

Is this okay?

What does it mean?

What happened?

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Three levels of processing
Seven principles

• Conceptual model
• Discoverability
• Feedback
• Affordances
• Signifiers
• Mappings
• Constraints
Knowledge in the world

- Precise behavior from imprecise knowledge
Knowledge in the world

• Precise behavior from imprecise knowledge

Neilsen’s heuristics:
- Recognition rather than recall
Errors: Slips vs. Mistakes

MISTAKES
errors in **choosing** an objective or **specifying** a method of achieving it

SLIPS
errors in **carrying out** an intended method for reaching an objective
Constraints

Neilsen’s heuristics:
- Error prevention
Error prevention

% rm -rf *
%

Internet Explorer

Do you want to close all tabs or the current tab?

Close all tabs  Close current tab

Always close all tabs
Metaphors

• Familiar example: the desktop metaphor
  – Not an attempt to simulate a real desktop
  – Leverage knowledge of files, folders, trash
  – Explains why some windows seem hidden

**Neilsen’s heuristics:**
- Match between system and real world
Metaphors
Mail metaphor
## Calendar metaphor

![Calendar screenshot](image)

### Calendar Overview

The image illustrates a computer calendar interface, likely used by a university to manage events. The calendar shows dates from January 3 to February 5, highlighting various scheduled events.

- **January 3**: 4:00pm DCS Colloquium
- **January 4**: 3:40pm Meet with Sharan, 9:30pm Meet with Jacob, 5:40pm CIF-OIO meeting
- **January 5**: 1:30pm Economics Meeting, 3:40pm Meet with Sharan, 9:30pm Meet with Jacob, 5:40pm CIF-OIO meeting
- **January 6**: 8:00am Faculty Lunch, 4:00pm DCS Colloquium
- **January 7**: 1:00pm Third Year with On
- **January 8**: 12:30pm CS 598 (1302 267), 3:00pm Meet with Sharan, 3:30pm Meet with Jacob, 5:40pm CIF-OIO meeting
- **January 9**: 10:00am Meet with Caroline, 12:30pm CS 598 (1302 267)
- **January 10**: 10:30am Dental Appointment, 4:00pm Joint seminar
- **January 11**: 12:30pm CS 598 (1302 267), 3:00pm Meet with Sharan, 3:30pm Meet with Jacob, 5:40pm CIF-OIO meeting
- **January 12**: 11:30am - 1:00pm Joint seminar
- **January 13**: 12:30pm CS 598 (1302 267)
- **January 14**: 12:30pm CS 598 (1302 267), 3:00pm Meet with Sharan, 3:30pm Meet with Jacob, 5:40pm CIF-OIO meeting
- **January 15**: HOLD FOR FACULTY REVIEW
- **January 16**: Out of office
- **January 17**: North Guioning Day End
- **January 18**: FIRST DAY OF CLASSES
- **January 19**: 2:30pm Meet with Heather, 4:00pm Joint seminar
- **January 20**: 12:00am Meet with Caroline, 12:30pm CS 598 (1302 267)
- **January 21**: 12:30pm CS 598 (1302 267)
- **January 22**: 12:30pm CS 598 (1302 267)
- **January 23**: 12:30pm CS 598 (1302 267)
- **January 24**: 12:30pm CS 598 (1302 267), 3:00pm Meet with Sharan, 3:30pm Meet with Jacob, 5:40pm CIF-OIO meeting
- **January 25**: 8:00am Faculty Retreat, 12:00am Faculty meeting, 4:00pm DCS Colloquium
- **January 26**: 12:30pm CS 598 (1302 267), 3:00pm Meet with Sharan, 3:30pm Meet with Jacob, 5:40pm CIF-OIO meeting
- **January 27**: 4:00pm Joint seminar
- **January 28**: 12:30pm CS 598 (1302 267)

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**Note:** The calendar entries are illustrative and may not reflect actual events.
Mechanical-Age Metaphors
Shallow/inappropriate metaphors

Microsoft Bob
Broken metaphors
Dead metaphors

- Milk
- Butter
- Cheese
- Water
- Beer
- Wine
Exercise

• Comment on design principles

EE/CSE elevators
HUMAN ABILITIES

...and their implications for design
Human abilities

• Humans:
  – Perception
    • Color, shape
    • Patterns (Gestalt principles)
  – Memory
  – Motor
    • Movement speed/precision (Fitt’s law)

Every artifact is the way it is because of human morphology or physiology.
Human visual system

Light passes through lens
Focussed on retina
Human visual system

• Retina covered with light-sensitive receptors
  – rods
    • primarily for night vision & perceiving movement
    • sensitive to broad spectrum of light
    • can’t discriminate between colors
    • sense intensity or shades of gray
  – cones
    • used to sense color
Human visual system

• Center of retina has most of the cones
  – allows for high acuity of objects focused at center

• Edge of retina is dominated by rods
  – allows detecting motion of threats in periphery
Color

• Powerful tool to improve user interfaces by communicating key information

• Inappropriate use can severely reduce the performance of systems
Visible spectrum
Color perception

• “Photopigments” used to sense color
• 3 types: blue, green, “red” (really yellow)
  – each sensitive to different band of spectrum
  – ratio of neural activity of the 3 determines color
    • other colors are perceived by combining stimulation
Color perception
Color sensitivity

not as sensitive to blue!
Color sensitivity

• Not distributed evenly
  – mainly reds (64%) & very few blues (4%)
  – insensitivity to short wavelengths (blue)

• No blue cones in retina center (high acuity)
  – “disappearance” of small blue objects you fixate on
  – As we age lens yellows & absorbs shorter wavelengths, sensitivity to blue is even more reduced
Color sensitivity

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Design implication:
  don’t rely on blue for text or small objects
Focus

• Different wavelengths of light focused at different distances behind eye’s lens
  – need for constant refocusing
  – causes fatigue

• Pure (saturated) colors require more focusing then less pure (desaturated)
Focus

• Different wavelengths of light focused at different distances behind eye’s lens
  – need for constant refocusing
  – causes fatigue

• Pure (saturated) colors require more focusing than less pure (desaturated)

*Design implication:* be careful about color combinations
don’t use saturated colors in UIs unless you really need something to stand out (stop sign)
Color guidelines

• Avoid simultaneous display of highly saturated, spectrally extreme colors
  – e.g. no cyans/blues at the same time as reds, why?
    • refocusing!

• desaturated combinations are better (pastels)
Color guidelines

• Using the hue circle: Pick non-adjacent colors
  – opponent colors create contrast
    • (red & green) or (yellow & blue)
Color guidelines

• Size of detectable changes in color varies
  – hard to detect changes in reds, purples, & greens
  – easier to detect changes in yellows & blue-greens

• Hard to focus on edges created by only color
  – use both brightness & color differences

• Avoid red & green in the periphery (no RG cones)

• Older users need higher brightness levels
Color guidelines

• Avoid pure blue for text, lines, & small shapes
  – also avoid adjacent colors that differ only in blue
• Avoid single-color distinctions
  – mixtures of colors should differ in 2 or 3 colors
  – helps color-deficient observers
Color blindness

• Trouble discriminating colors
  – besets about 9% of population

• Two main types
  – different photopigment response most common
    • reduces capability to discern small color diffs
  – red-green deficiency is best known
    • lack of either green or red photopigment
      can’t discriminate colors dependent on R & G
Attention/saliency
Attention/saliency
Patterns
Gestalt principles

• Closure
• Good continuation
• Proximity
• Similarity
Gestalt principles - proximity

Elements that are closer together are perceived to be more related than elements that are farther apart.
Gestalt principles - similarity

Elements are **similar** are perceived to be more related than elements that are dissimilar.
Gestalt principles - closure

A tendency to perceive a set of individual elements as a single, recognizable pattern, rather than multiple, individual elements.
Gestalt principles - good continuation

Elements arranged in a **straight line or a smooth curve** are perceived as a group and are interpreted as being more related than elements not on the line or curve.
Exercise

• Comment on Gestalt principles
  – Closure
  – Good continuation
  – Proximity
  – Similarity
Perception of time/change

How soon must red ball move after cue ball collides with it?

must move in < $T_p$ (100 msec)
Perception of time/change

• Stimuli that occur within one cycle fuse into a single concept
  – frame rate needed for movies to look real?
  – time for 1 frame < Tp (100 msec); that is 10 frame/sec.

• Perceptual causality
  – two distinct stimuli can fuse if the first event appears to cause the other
  – events must occur in the same cycle
Memory

- **Working memory (short term)**
  - small capacity (7 ± 2 “chunks”)
  - 6174591765 vs. (617) 459-1765
  - DECIBMGMGMC vs. DEC IBM GMC
  - rapid access (~ 70ms) & decay (~200 ms)
  - pass to LTM after a few seconds of continued storage

- **Long-term memory**
  - huge (if not “unlimited”)
  - slower access time (~100 ms) w/ little decay
Speed of accessing memory

Paper
Home
Back
Schedule
Page
Change

Yellow
White
Black
Blue
Red
Green
Speed of accessing memory

• Interference
  – two strong cues in working memory
  – link to different chunks in long term memory

• Why learn about memory?
  – know what’s behind many HCI techniques
  – helps you understand what users will “get”
  – aging population of users
Recall versus recognition

Recall
  reproduce information from memory
Recognition
  discriminate among provided info