MIE 240: Human-centred system design

Controls

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Learning Objectives

- Describe the various types of controls
- Discuss control-task pairings
- Understand control design principles (*response selection principles, attention, perceptual, memory, mental model*)

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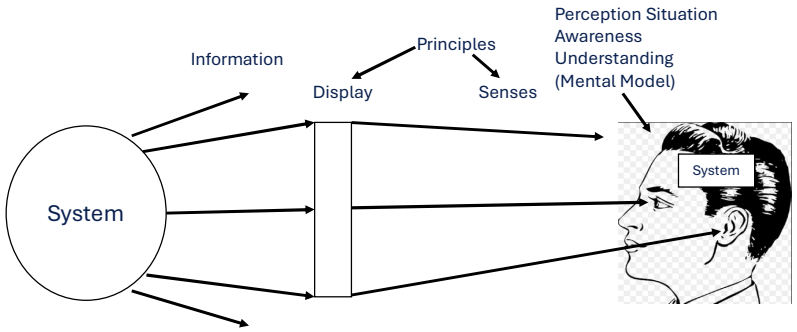
Last Lecture

- Discussed display variables and their match to the task
- Described display design principles (*attention, perceptual, memory, mental model*)



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Principles – Display Design

15 principles of display design grouped under four categories:

1. Principles based on Attention
2. Perceptual Principles
3. Mental Model Principles
4. Memory Principles

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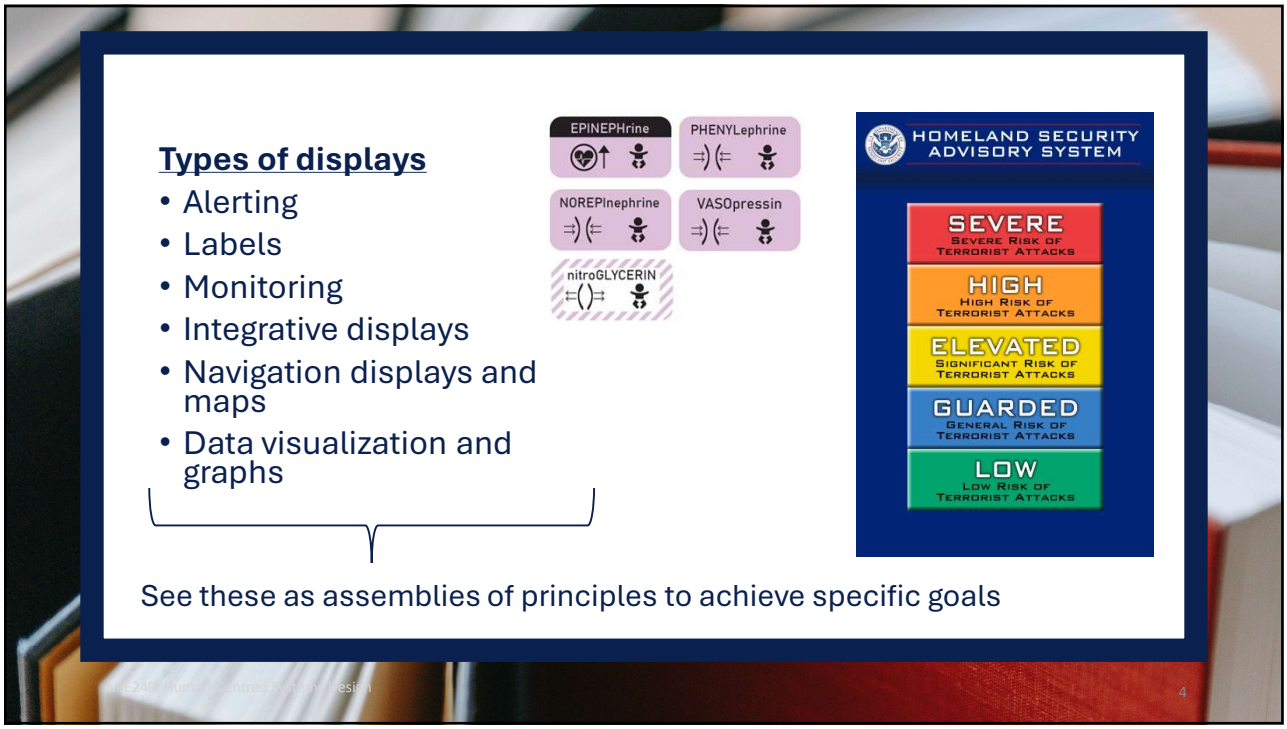
Types of displays
• Alerting
• Labels
• Monitoring
• Integrative displays
• Navigation displays and maps
• Data visualization and graphs
EPINEPHrine
PHENYLephrine
NOREPInephrine
VASOpressin
nitroGLYCERIN
HOMELAND SECURITY ADVISORY SYSTEM
SEVERE
SEVERE RISK OF TERRORIST ATTACKS
HIGH
HIGH RISK OF TERRORIST ATTACKS
ELEVATED
SIGNIFICANT RISK OF TERRORIST ATTACKS
GUARDED
GENERAL RISK OF TERRORIST ATTACKS
LOW
LOW RISK OF TERRORIST ATTACKS
See these as assemblies of principles to achieve specific goals
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Controls

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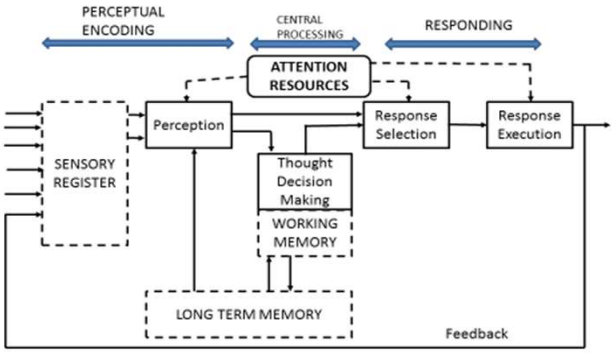
Control

- Difficulties in control can be placed in context of human information processing model
- Control is the [illegible] and [illegible] part of human information processing model



Information processing model

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Types of controls

Controls and tasks – discrete vs. continuous, number of states (on/off vs 3+), point and select vs. tracking values

Push button

Toggle

Round knob (Dial)

Selector Switch

Voice

Lever

Keyboard

Mouse & joystick

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Control Design Principles

Attention principles

- Proximity compatibility
- Avoid resource competition

Memory principles

- Knowledge in the world
- Be consistent

Perception principles

- Make accessible
- Make discriminable
- Avoid absolute judgment limits
- Exploit redundancy gain

Mental model principles

- Location compatibility
- Movement compatibility

Response selection principles

- Avoid accidental activation
- Hick-Hyman Law
- Decision complexity advantage
- Fitts's Law
- Provide feedback

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Perceptual Principles

make accessible

- Controls should be easily reached

Controls should be easily reached

Inaccessible ceiling fan control

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Perceptual Principles

Make accessible- Controls should be easily recognized

Do drivers understand these icons?

Consider other controls users may access with use of the device

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Interesting case of remote controls

Various types of remote controls

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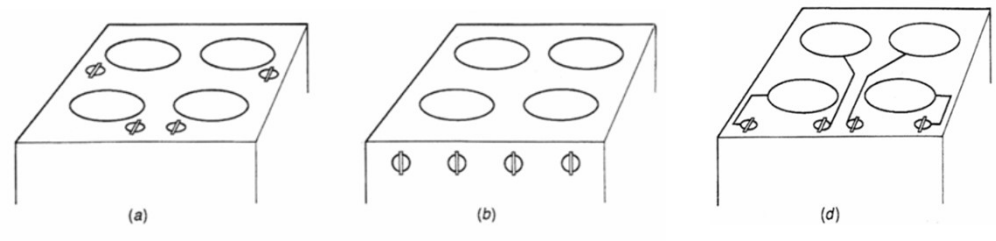
Mental Model Principles

Location compatibility

colocation principle: put the control and the display in the same location

- *Touch screens take this idea to the limit*

Congruence principle: Spatial array of controls is congruent with the spatial array of objects being controlled



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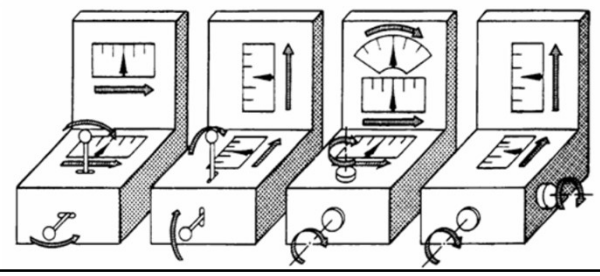
Mental Model Principles

Movement compatibility

- Movement of the control should correspond to the movement in the display
- Or use *common conventions* (for example to show an increase: move a control up, to the right, forward, or clockwise)

principle of moving parts



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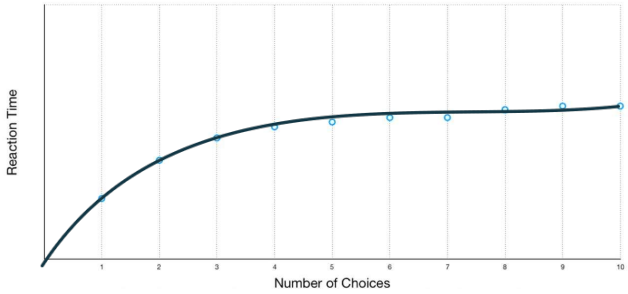
Principles of Response Selection

- The *difficulty* and *speed of selecting* a response or an action is influenced by several variables:
  - Decision Complexity
  - Expectancy
  - Compatibility
  - Speed accuracy trade off
  - feedback



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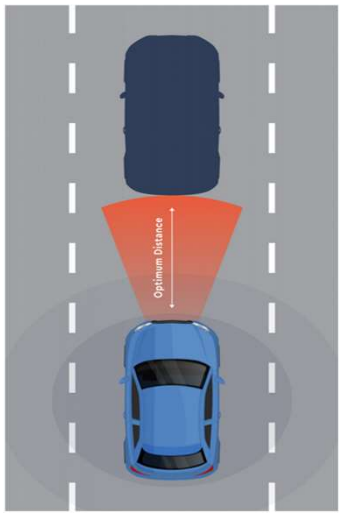
Principles of Response Selection

Response Expectancy

- We rapidly perceive information which we expect
- We rapidly execute the actions which we expect are to be carried out rather that the surprising ones
- *Example* – we don't expect car in front of us on a freeway to come to an unexpected halt



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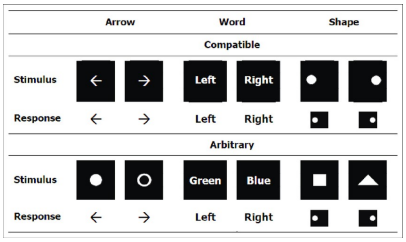
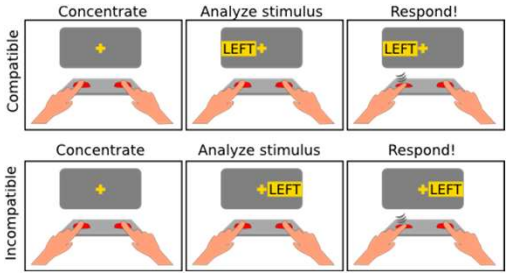
Principles of Response Selection

Compatibility

Stimulus-response compatibility: expected relationship between **the location of a control** or movement of a control response and the location or **movement of the display** to which the control is related

- location compatibility - control location should be close to display being controlled
- movement compatibility - direction of movement of control must be congruent with direction of entity/display





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Example: flying a drone

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Principles of Response Selection

R11. avoid accidental activation

- Design controls such that they are not inadvertently bumped or depressed
- Ensure users are aware of correct state and have sufficiently considered circumstances

Accidental activation

Old design

New design

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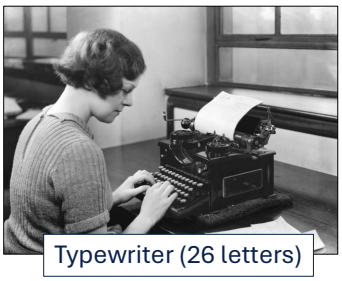
Principles of Response Selection

R12. Hick Hyman Law of reaction time

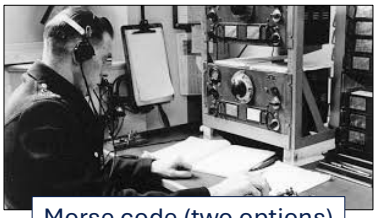
reaction time is a function of the number of alternatives

- N = Number of alternatives
- RT = Reaction time
- RT = a + b*Log2(N)

- Speed with which an action can be selected is strongly influenced by the # of alternatives that could be selected
- User can select an option in a menu more quickly if the there are only two options



Typewriter (26 letters)



Morse code (two options)

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Principles of Response Selection

R13. Decision complexity

- Hick-Hyman Law **does not imply** that system designed to make users tasks simpler are superior
- More efficient to require a smaller number of complex decisions than many simple decisions

Shallow menus with more items tend to be faster and easier to use than deep menus with fewer items

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Principles of Response Selection

R14. Fitts law Speed accuracy tradeoff

Speed-accuracy tradeoff in pointing movement **Movement time = a + b *log*2(2A/W)**

- A = movement amplitude
- W = target width (error tolerance)
- **a** and **b** depend on user/device characteristics (empirical)
- Index of difficulty: ID= *log*2(2A/W)

Fitts' Law

In plain words:

Big and near objects are easy to click.

Small and far objects are hard to click.

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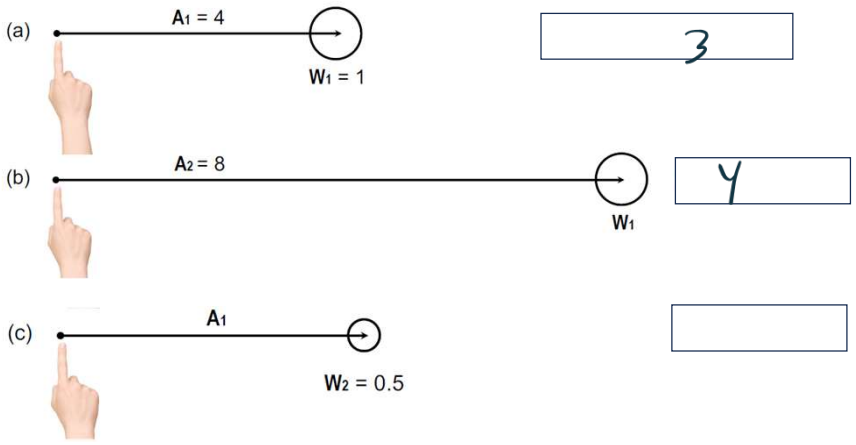
Principles of Response Selection

The time to acquire a target is a function of the distance and size.



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dist & size

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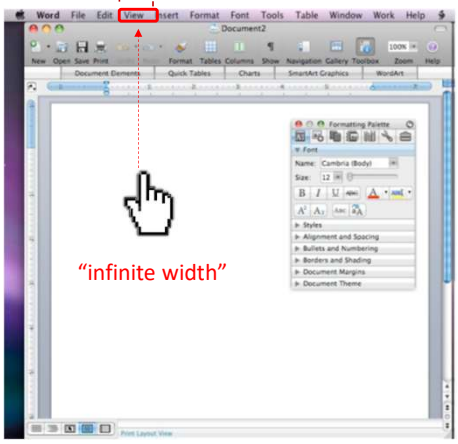
Principles of Response Selection

Fitts' Law/Speed accuracy tradeoff

- If we try to carry out actions too quickly, we are more prone to making errors
- Tradeoff are caused by user strategy
- Sometimes control devices differ in speed accuracy tradeoff
- Big and close targets are acquired faster than small and distant targets



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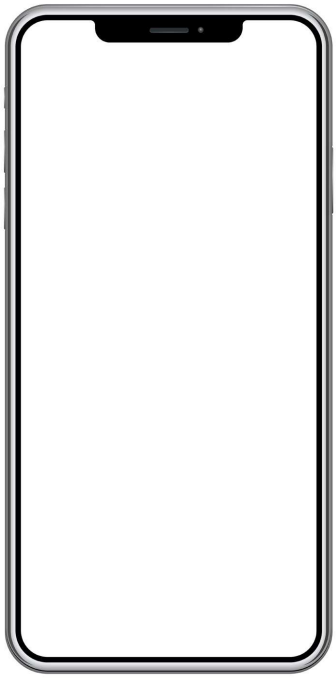
Where do you place your most used apps on your homescreen?



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Principles of Response Selection

R15._____

- Most controls are associated with some kind of visual feedback
  - Example: Effect of turning steering wheel causes change in direction
- Good controls gives feedback of control state
- Feedback >100msec can be harmful if rapid responses are required (Need skilled operator)

Visual feedback

Lack of haptic feedback in robotic assisted surgery

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Summary

15 principles of principles of display design grouped under 5 distinct categories:

- Attention principles
- **Perceptual principles** (make accessible)
- Memory principles
- **Mental model principles** (location and movement compatibility)
- **Response selection principles**
  - Decision Complexity
  - Expectancy
  - Compatibility
  - Speed accuracy trade-off
  - Feedback
- Hick Hyman Law of Reaction Time (RT)- reaction time is a function of the number of alternatives
- Fitts's Law - Movement time (MT) is a function of on amplitude of the movement and the width of the target

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Next lecture (Wed., Feb. 5)

Topic: Controls (discrete and continuous controls)
Review: Ch. 9 (9.3.1 – 9.3.5)
Review questions: 9.8, 9.16, 9.19, 9.22

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