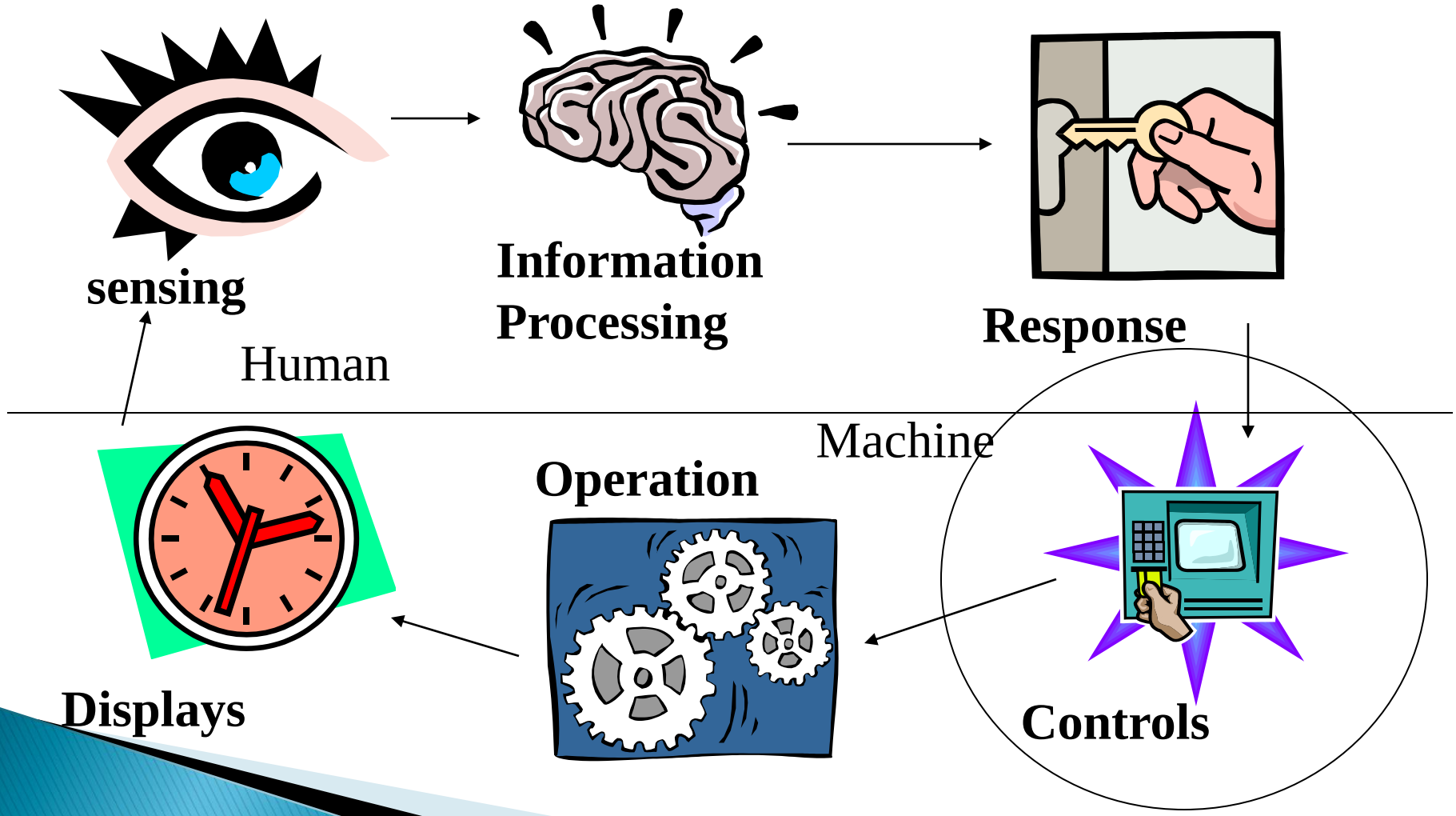
Controls

Spring 2013
Human Factors Engineering

Learning Objectives

- Control Options
- Response Selection
- Designing Discrete Controls
- Position Control Devices
- Limitations of Voice Input
- Continuous Control and Tracking
- Remote Manipulation or Tele-robotics

Human Machine Interactions



Goals

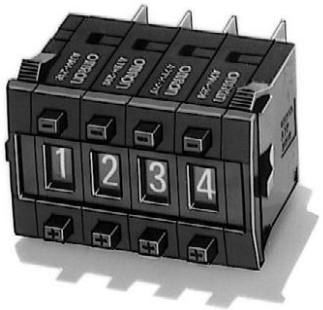
- Increase speed of action selection and decrease error rates or difficulty
  - We select quicker if there are (2) TWO choices, NOT (8) eight.
  - Decision Complexity Advantage:
    - Fewer complex decisions more efficient than many simple decisions

  EXAMPLES of fewer choices would be computer menus

  Any others come to mind?

Responses are longer when there are complex decision, unexpected actions or incompatible responses = errors

Types



1. Push Button
2. Toggle Switch
3. Rotary Selector Switch
4. Discrete Thumbwheel
5. Knobs
6. Cranks and Levers
7. Hand/Steering Wheels
8. Pedals
9. Joy Stick

Decision Complexity

- Fewer selections
- Typing vs. Morse code (2 or 26 options)
- BUT a typist can convey the message faster than the Morse code operator

Remember – the goal is to increase choice accuracy

Response Expectancy

- You will respond slower if you are NOT expected to react, i.e. Someone stopping abruptly on the freeway.
- You react quicker when the action is what you expected to see

Compatibility

- Control is near what is being controlled
- Control moves in direction of change it is controlling, e.g. moving lever to the left means part moves to the left
- The control that ignites a particular burner is closest (and sometimes with a diagram on the knob to indicate)

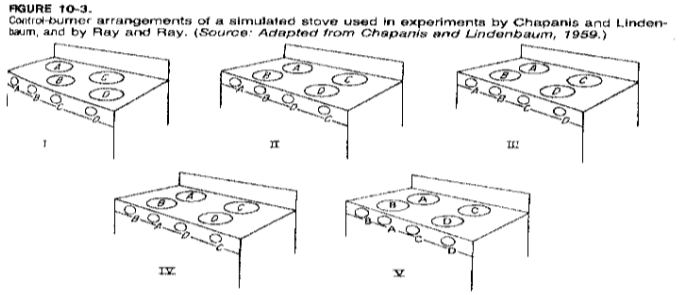


FIGURE 10-3.
Control-burner arrangements of a simulated stove used in experiments by Chapanis and Lindenbaum, and by Ray and Ray. (*Source: Adapted from Chapanis and Lindenbaum, 1959.*)

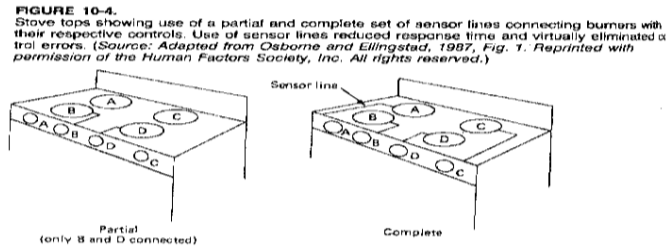


FIGURE 10-4.
Stove tops showing use of a partial and complete set of sensor lines connecting burners with their respective controls. Use of sensor lines reduced response time and virtually eliminated control errors. (*Source: Adapted from Osborne and Ellingstad, 1987, Fig. 1. Reprinted with permission of the Human Factors Society, Inc. All rights reserved.*)

Speed-Accuracy Tradeoff

- *EITHER….*Longer response time = higher level of accuracy = positive correlation
- *OR….*When we are rushed, consequence of errors is critical.
  - If we are late will go faster and likely to make more errors.
  - If critical will move slower and be more accurate… negative correlation.

Feedback

- System response to control input
  - Speedometer
  - Hourglass that tells you your computer is thinking
  - Accelerator and speedometer
  - Dimmer and lights
  - Steering wheel and car turning
  - Braking and car slowing
  - Light switch

Coding of Controls

- Shape
- Texture
- Size
  - Use anthropometrics
- Location
- Operation Method:
  - push button, turn/rotate, slide
- Color
- Label

Resistance

- Elastic Resistance
- Frictional Resistance
- Viscous-damping resistance
- Inertial resistance

Accidental Activation

- Covering
- Locking
- Resistance
- Location
- Recessing
- Orientation

Discrete Control Design

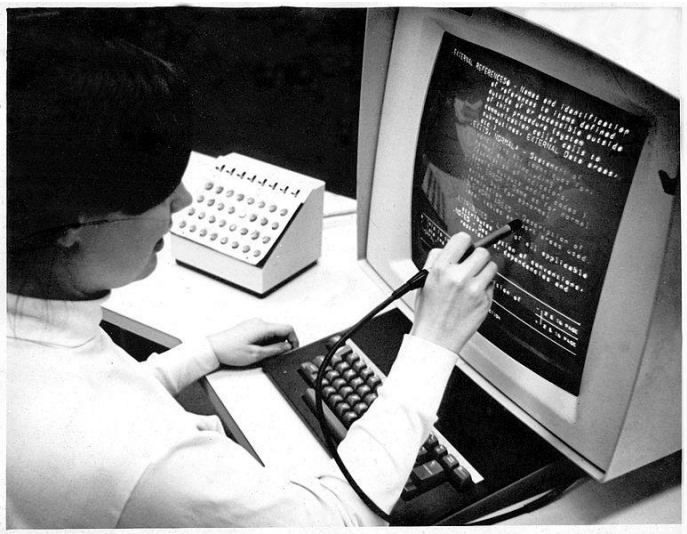
- Physical Feel
  - Toggle switch (feedback)
  - Tupperware
  - Car AC
  - Others….
- Size – tiny keypads
- Confusion & Labeling
  - Do lights mean on or off?
  - Is this “V” a mistake?

Movement Time

- Hand moves to the control
- The control is moved and points to something
- Difficulty of movement due to distance or size of device

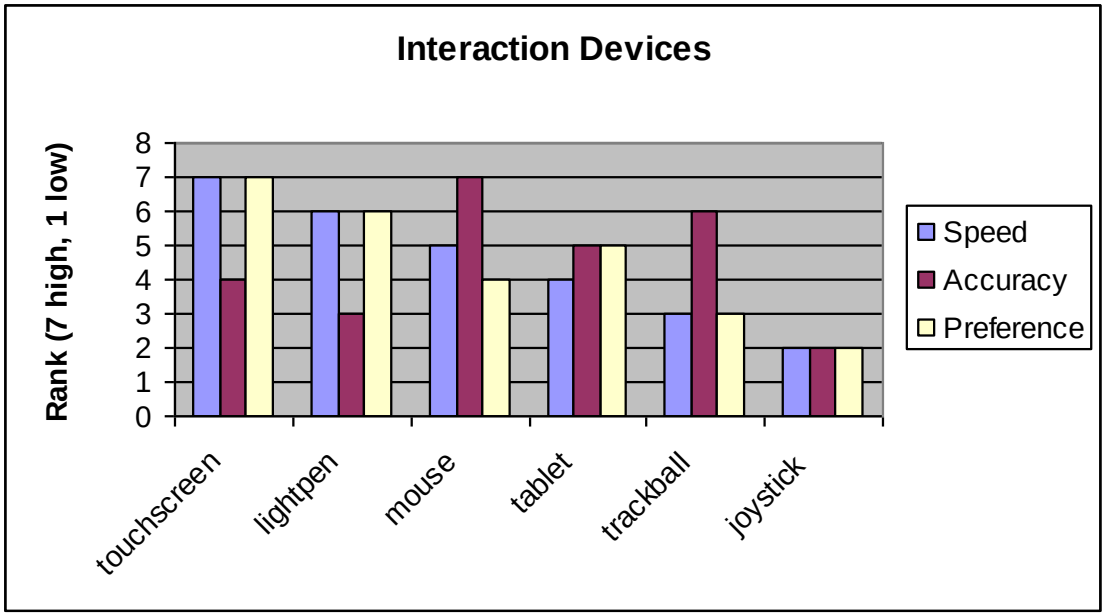
Device Characteristics

- Direct position = Touch screens, light pen
- Indirect position = Mouse or touch pad
- Indirect Velocity Controls = Joystick
- Usability issues…
  - Feedback-salient, visible and immediate
  - Performance affected by gain, i.e. how sensitive - small touch = big movement



Task Performance Dependence

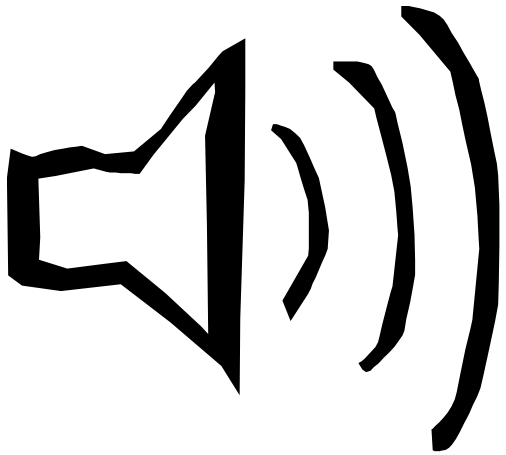
- Accuracy vs speed trade-offs.. 7 = best, 1= worst (opposite range than the book)



- "… speed-accuracy trade-off between direct position controls, which tend to be very rapid but less accurate (i.e. touch screen) vs the mouse which is slower but generally more precise.."

Work Space Environment

- Display size
- Can be at a desk or in a truck
- Noise level (bad for voice)
- Direct positioning bad in a vibrating/moving environment



- “For isolated words, voice control is faster than typing, but only when typing speed is less than 45 words/minute, and for numerical data entry, the mouse or keypad are superior.”

Limitations of Voice Input

- Good for disabled people
- Should not be confused with other controls
  - In an emergency, will operators know what to do?
  - Probably not good in emergencies when people are stressed or distracted
- May be a challenge/take time to generate.
  - Voice recognition may not handle natural speech

Example: Bluetooth not recognizing words. Options may be wrong.

Concepts:

- Confusion & limited vocabulary size
- Constraints on speed
- Acoustic quality, noise & stress
- Compatibility

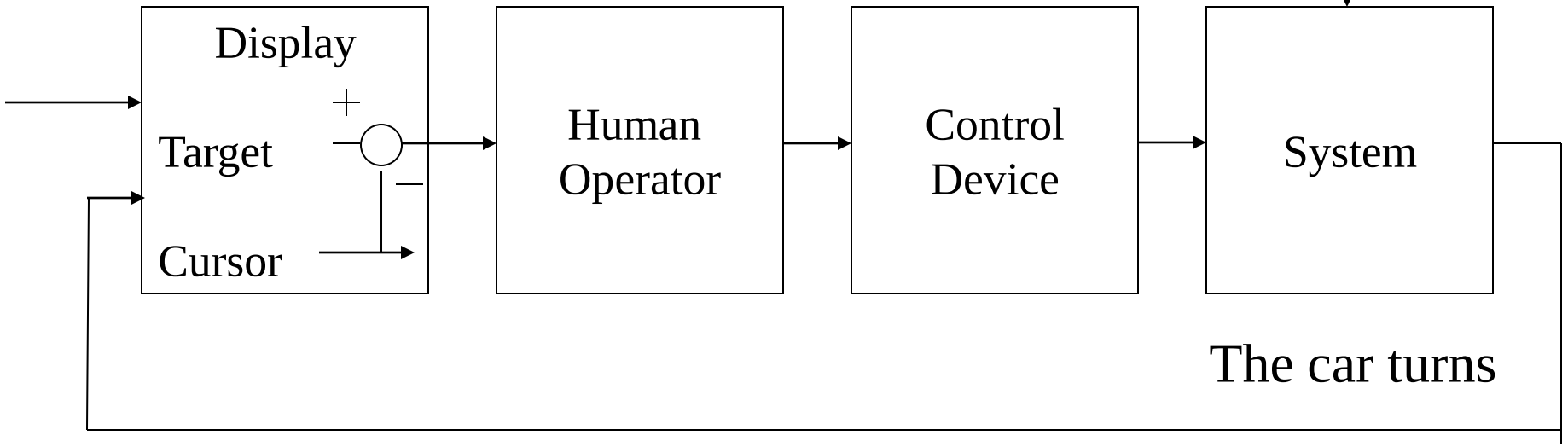
Tracking Loop

See that the car is not in the center of the road

Driver decides to correct the error

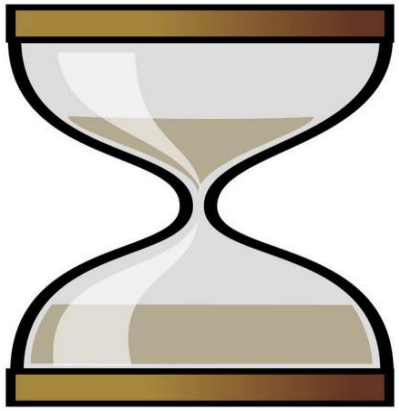
Turns the steering wheel

Disturbance Input

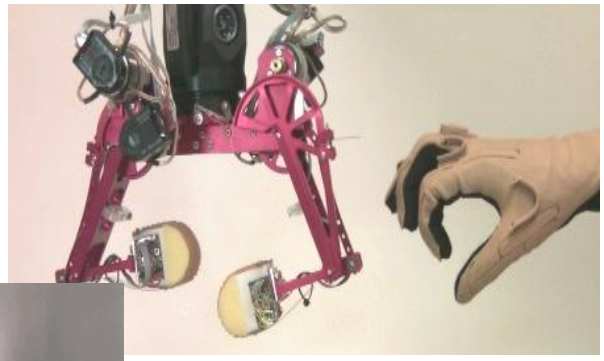


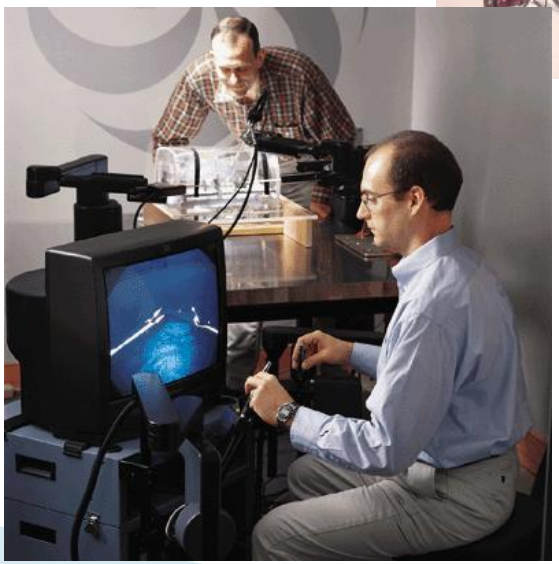
Display and the control are both important in the decision making and action taking…. The response of the system to the control change

Remote Manipulation or Telerobotics



- Time Delay
- Depth Perception & Image Qu
- Tactile Feedback





Summary

- List the various options for controls…
  Push button, toggle, etc…
- Describe the principles of response selection…decision complexity, response expectancy, compatibility, coding, resistance, speed-accuracy tracking, feedback, accidental activation
- Know how to best design discrete controls… physical feel, size, confusion & labeling
- Know how to position control devices…
  movement time, device characteristics, task performance dependence, work space environment

Summary cont…

- Describe the limitations of voice input…limited vocabulary size, speed, acoustic, compatibility
- Know what is meant by continuous control and tracking…command input, display, operator, control device, system response, command input….
- Know some of the advances in remote manipulation or tele-robotics... time delay, depth perception & image quality, tactile feedback