

Human Factors for Input Devices

CSE 510
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Today's lecture

- Input devices
 - Restrict attention to mechanical input devices
 - Mice
 - Keyboards
 - Pens
- What are issues relating to input?
- How do you evaluate different devices?

Input devices

- What is the goal of an input device?

To provide human controllable signals to the application

- Natural metrics
 - Efficiency
 - Accuracy

How many input devices?

Discrete input devices
Keyboards
Buttons
Key pads

Continuous input Devices
Mice
Trackball
Pens
(maybe higher dim)

Are there really just Two??

What makes one input device better than another?

Collective brain storm
Performance
Speed, accuracy
Ease of sustained use
Ease of learning
Responsiveness

Aesthetic
Comfort

What makes an input device easy to use?

Accurate and predictable
Action
Physical feedback
Fast visual feedback

Limited (but not too limited) range of motion

Low cognitive load

Toleration of Delays

- How fast is fast enough?

This depends on the user experience.

Distinction

- Task completion
- Compiling
- Loading page
- Physical – causality
- Billiards example
- Ink following pen

Anecdote

- Most excited Ed
- 9.2 K modem

Job completion times

- Effect of execution on completing a job

The first graph shows 'Software development time' on the y-axis and 'Compilation time' on the x-axis. A box labeled 'Limited effect' is placed above the x-axis, indicating that as compilation time increases, the total software development time does not increase proportionally.

The second graph shows 'Payroll entry' on the y-axis and 'Database Update time' on the x-axis. A box labeled 'Roughly linear' is placed above the x-axis, indicating that as database update time increases, the total payroll entry time increases in a roughly linear fashion.

Response time

RSI

The basic point to make is that there are considerations about IO devices beyond the run time of the application.

- Repetitive Strain Injury
 - What is it?
 - What causes it?
 - How to avoid it?

Keyboard facts

QWERTY
5 ks / sec (expert 15)
Dvorak +33%
Corded 30 ks/sec
Info theory
Compare with Piano

Physical issues
Size, pressure, shape,
Finish, auditory, travel
Time, spacing

Numeric keypads,
Cursor control
Lack of consistency
In layout

Pointer Facts

Mouse
Dominant desktop pointing device
Accurate positioning
Stationary
Variety of buttons, scroll wheels
Ergonomics issues
optimal for three hands
Alternate pointing devices for restricted area
touchpad, trackpoint, trackball

Game controls


Most devices hybrid
Pointing + discrete

Stylus Facts

- Pen input and touch Screen
- Technologies covered on Monday
- Potentially higher dimensions than mouse
- Much better fine control (writing with a mouse)
- Direct input on screen pros and cons
- different metaphors from desktop
- Touch screen
- Natural for some apps
- Ideal for public devices
- Lack of precision

Device issues

- Efficiency of completing task
 - Speed
 - Accuracy
- Speed vs Accuracy
 - What does the curve look like
 - Where are you on the curve?



Adoption

- Learning curve
 - Novice
 - Intermediate
 - Expert

Socio-economic issues

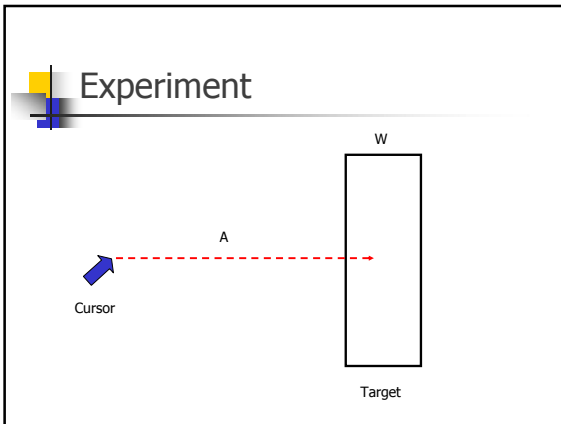
- Variety of users
- Advantages of general adoption
- Inertia
 - Cost of change outweighs benefits of change

Evaluation of input devices

- Is it possible to rigorously evaluate input devices?
- Study performance of atomic tasks with specific devices.
- Look for measures of complexity
 - Predictive?
 - Comparative?
 - Models of actions and devices

Fitts' law

- A tasks movement difficulty is given by $ID = \log_2(2A / W)$
 - ID – index of difficulty
 - A – amplitude of the move
 - W – width of the target region



- ### Standard experiment
- Compute Movement Time (MT) for range of A's and W's
 - Plot ID vs. MT
 - Computer linear fit
 - $MT = a + b ID$
 - Extremely good fit in empirical tests
 - But plenty of room for criticism

- ### Issues
- High correlations have been reported
 - E.g., $r = .992$, $MT = 53 + 148 ID$
 - Sometimes the intercept have been large
 - E.g., $r = .91$, $MT = 1030 + 96 ID$
 - The model breaks down if $W > 2A$
 - So maybe use $ID = \log_2(A/W + 1)$

- ### What does the law say?
- Relative accuracy determines difficulty
-
- Comparison of Pie menus and linear menus?

- ### Where the law breaks
- Large distances
 - 1/2 inch target at 1 inch vs 1/2 mile target at 1 mile
 - Small distances
 - Suggests zero movement for selection from pie menus
 - Ignores minimum targeting range

- ### Extensions
- Considering accuracy in the model
 - Adding additional parameters
 - E.g., movement time



Implications

- Supporting measurement based research
- Allow more rigorous conclusions
 - The mouse is optimal
 - Targeting the mouse has same coefficients as targeting the hand