CS160: User Interface Design

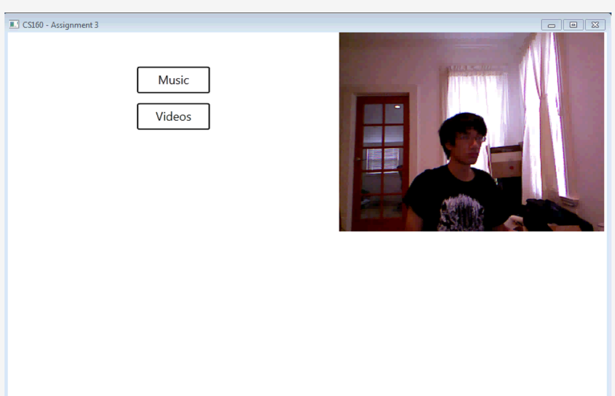
Input Devices 02/15/12

Berkeley
UNIVERSITY OF CALIFORNIA

Assigned: IPA 3 (due Feb 27)

Control your media browser using the Kinect

(Combine IPA1 and IPA 2)



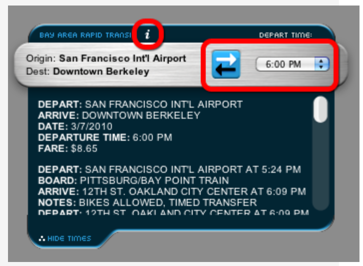
Assigned: Ind. Heuristic Eval. (due Feb 22)

Apply Nielsen's notes on Heuristic Evaluation to application of your choosing

Example: BART Trip Planning

Heuristic: Consistency and Standards

Explanation: The interface offers inconsistent ways to change different trip options. While a dropdown box to choose departure time and a button to reverse stations are available on the main screen, the origin and destination stations cannot be changed on this screen. To change these options, the user must click on the "i" icon in the top bar (which only becomes visible on mouse rollover).



Severity: 3 = Major usability problem: important to fix, so should be given high priority. I rank this problem as major because it occurs frequently - every time the user wants to change stations; and because it is persistent - there is no way for the user to change application behavior to put all controls on the same page.

Contextual Inquiry and Task Analysis

Due Feb 22

Find and interview 3 target users (not from class)

Analyze their tasks

Explain how your application addresses their needs

Compare to five closest existing applications

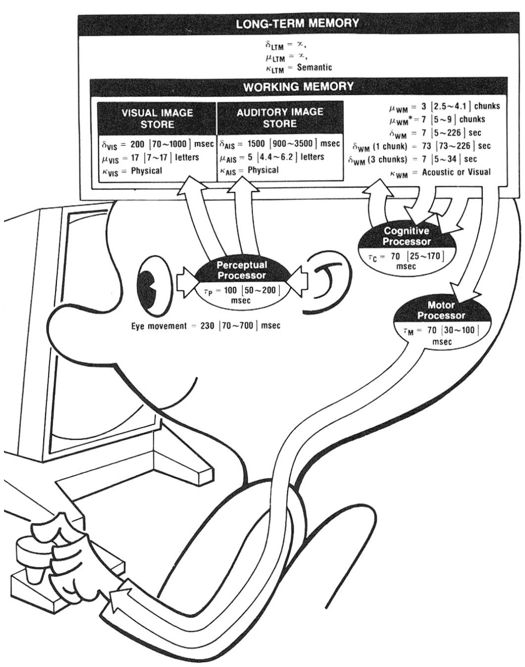
See wiki for details

Start now!

Finding participants will take time

We will not accept late group project assignments

The Model Human Processor



Human Info. Processor

Processors:

- Perceptual
- Cognitive
- Motor

Memory:

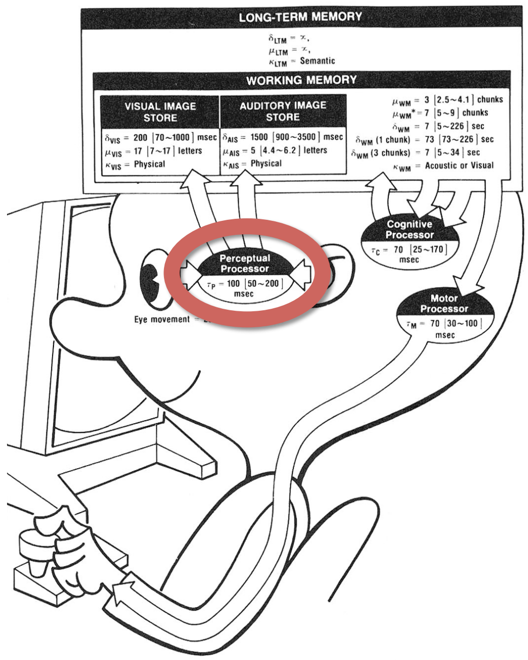
- Working memory
- Long-term memory

Unified model

Probably inaccurate

Predicts perf. well

Very influential

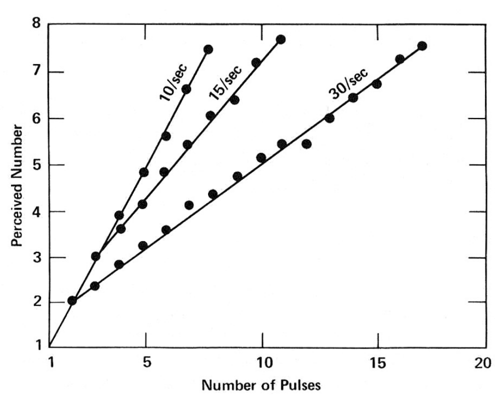


Perceptual Processor

Cycle time

Quantum experience: 100ms

Percept fusion



Working Memory

Access in chunks

Task dependent construct

7 +/- 2 (Miller)

Decay

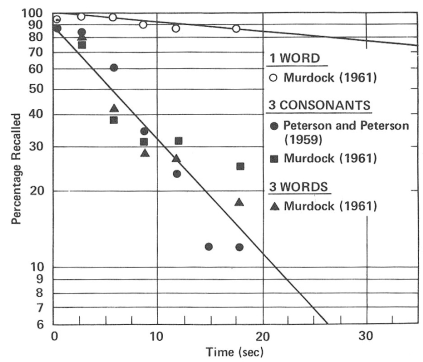
Content dependant

1 chunk 73 sec

3 chunks 7 sec

Attention span

Interruptions > decay time



Long Term Memory

Very large capacity

Semantic encoding

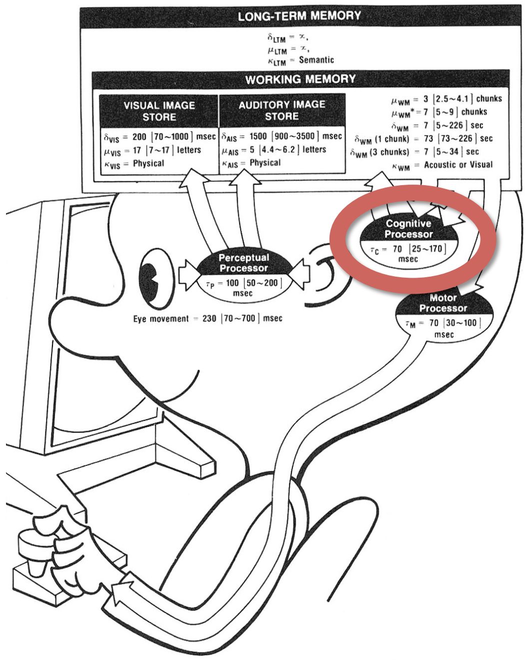
Associative access

Fast read: 70ms

Expensive write: 10s

Can also move from WM to LTM via rehearsal

Context at the time of acquisition key for retrieval



Cognitive Processor

Cycle time: 70ms

Can be modulated

Typical matching time

Digits: 33ms
Colors: 38ms
Geometry: 50ms…

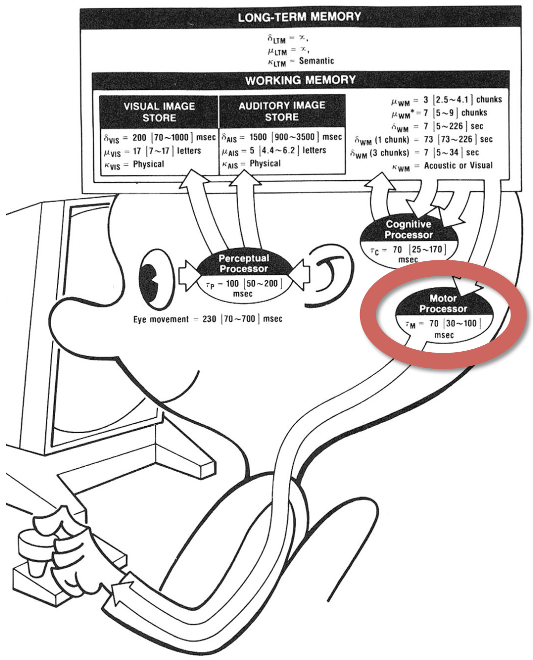
Fundamentally serial

One locus of attention at a time

Eastern 401, December 1972

Crew focused on landing gear indicator bulb,
Aircraft is loosing altitude (horn, warning indicator…),
Aircraft crashed in the Everglades
see "The Human Interface" by Raskin, p25

But what about driving and talking?



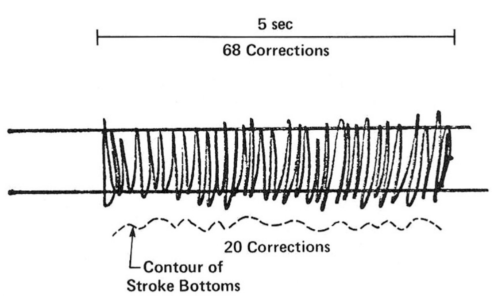
Motor Processor

Receive input from the cognitive processor

Execute motor programs

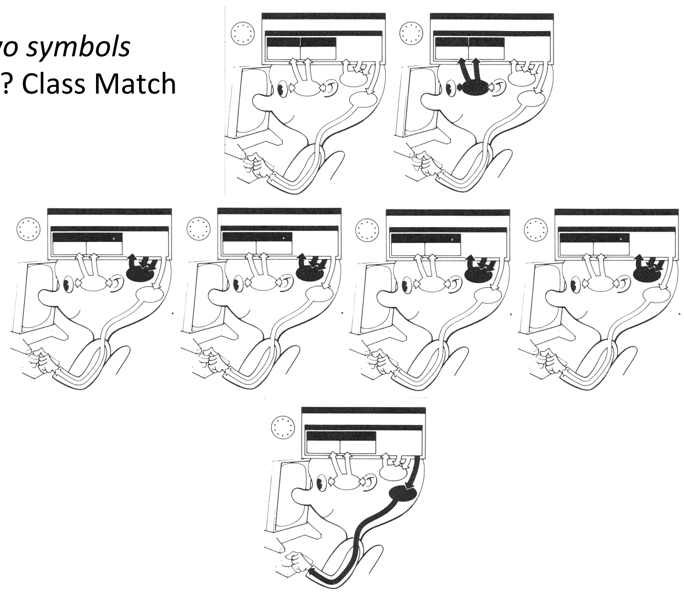
Pianist: up to 16 finger movements per second

Point of no-return for muscle action



Recognize-Act Cycle

Are *two symbols* letters? Class Match



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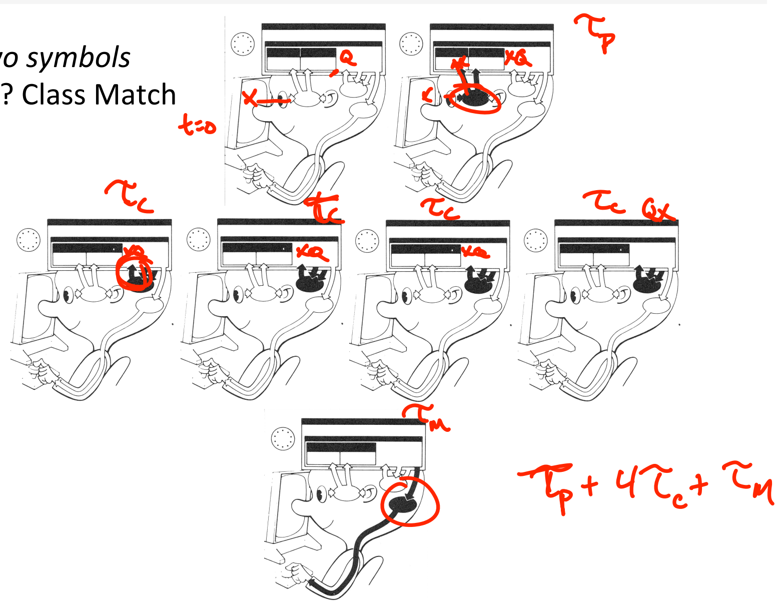


Cognitive Processor

Page 70 of Card Moran and Newell

Clocks starts when 2nd letter is flashed
Move 2nd symbol into visual store WM

T_p

Recognize the symbol as codes

+ T_c

Classify the codes as letters

+ T_c

Match the fact that they are both letters

+ T_c

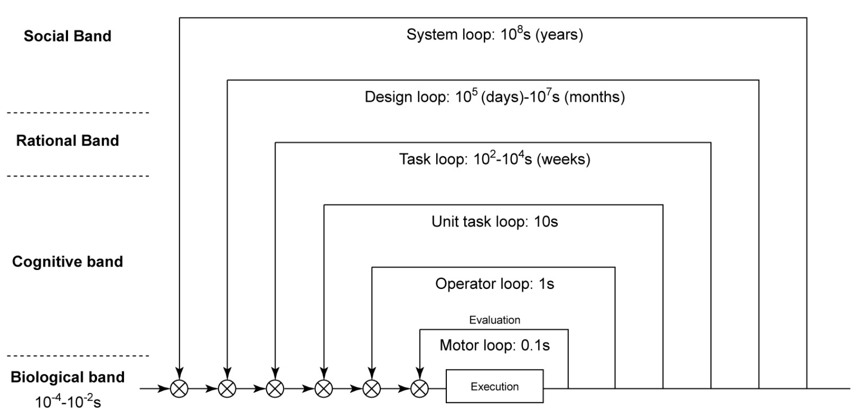
Initiate motor response + T_c

Process motor command +T_m

Approx 450 (180-980) ms

Human Interaction Loops

(Newell)



Memory

Simple Experiment

Volunteer

Start saying colors you see in list of words

- When slide comes up
- As fast as you can

Say "done" when finished

Everyone else time it…

Schedule
Paper
Page
Back
Change
Home

Simple Experiment

Do it again

Say "done" when finished

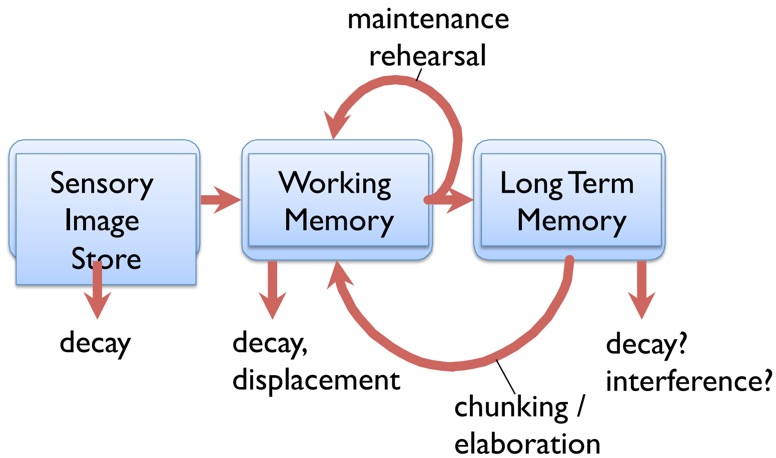
Blue
Red
Black
White
Green
Yellow

Interference

Stroop Effect:
when the *color spelled out by a word* is incongruent with the *color used to show* that word, naming the word color is slower and more error prone.

Explanation: relationship between meaning and physical form of stimulus are in conflict.

Stage Theory



Stage Theory

Working memory is small

- Temporary storage
  - decay
  - displacement

Maintenance rehearsal

- Rote repetition
- Not enough to learn information well

LTM and Elaboration

Recodes information

Organize (chunking)

Relate new material to already learned material

Link to existing knowledge, categories

Attach meaning

- Make a story

LTM Forgetting

Causes for not remembering an item?

1) Never stored: encoding failure
2) Gone from storage: storage failure
3) Can't get out of storage: retrieval failure

Interference model of forgetting

One item reduces ability to retrieve another

Proactive interference (3)

- Earlier learning reduces ability to retrieve later info.

Retroactive interference (3 & 2)

- Later learning reduces the ability to retrieve earlier info.

Recognition over Recall

Recall

Info reproduced from memory

Recognition

Presentation of info helps retrieve info (helps remember it was seen before)

Easier because of cues to retrieval

We want to design UIs that rely on recognition!

Recall

Recognition

Grouchy
Sneezy
Smiley
Sleepy
Pop
Grumpy
Cheerful
Dopey
Bashful
Wheezy
Doc
Lazy
Happy
Nifty

Recognition

Grouchy
Sneezy
Smiley
Sleepy
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Grumpy
Cheerful
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Lazy
Happy
Nifty

Facilitating Retrieval: Cues

Any stimulus that improves retrieval

Example: giving hints

Other examples in software?

- icons, labels, menu names, etc.

Anything related to

Item or situation where it was learned

Summary

Model human processor

- 5 parts
  - Perceptual processor
  - Working memory
  - Long term memory
  - Cognitive processor
  - Motor processor
- May not be biologically accurate
- But ...
  - Provides rough estimate of performance
  - Can help us compare and evaluate interfaces

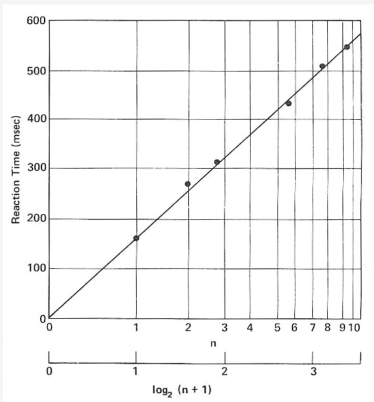
Interfaces should both aid and exploit human capabilities

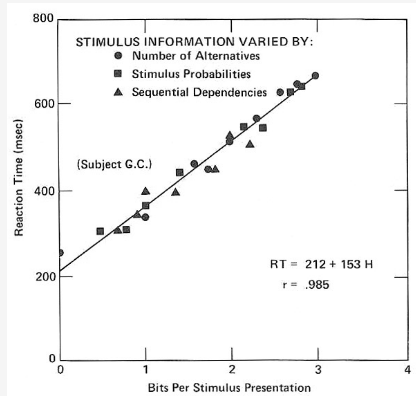
Decision Making and Learning

(cc) Image by colodio (flickr)

Hick's Law

Cost of taking a decision: $T = a + b\log_2(n+1)$





Power Law of Practice

Task time on the nth trial follows a power law

$$T_n = T_1 n^{-a} + c$$

where a = .4, c = limiting constant

Power Law of Practice

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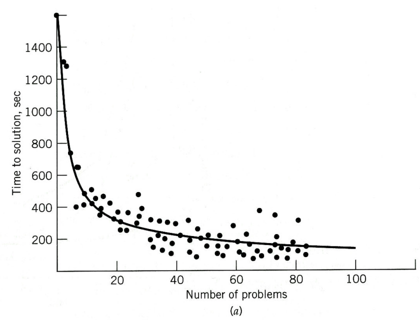
You get faster the more times you do something!



Power Law of Practice

Task time on the nth trial follows a power law

$$T_n = T_1 n^{-a} + c$$

where a = .4, c = limiting constant

You get faster the more times you do something!

Applies to skilled behavior (sensory & motor)

Does not apply to

Knowledge acquisition

Improving quality

Stages of Skill Acquisition

Example: Using a manual transmission

Cognitive

Verbal representation of knowledge

Associative

Proceduralization

Form of chunking

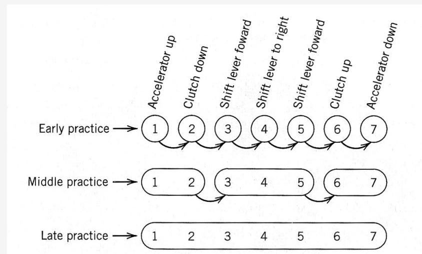
Autonomous

More and more automated

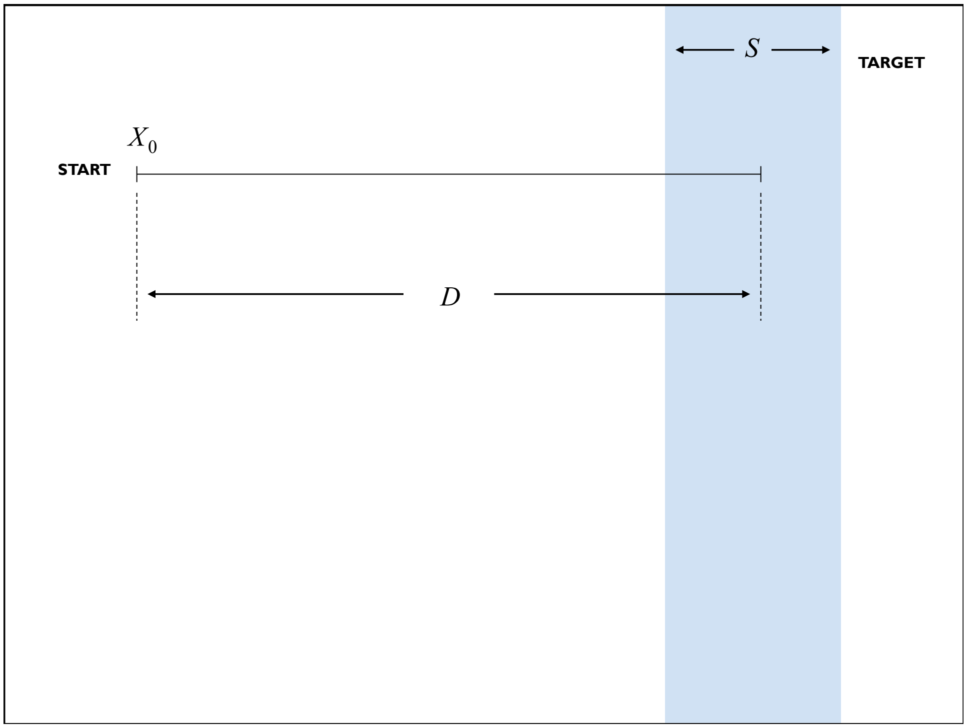
Faster and faster

No cognitive involvement

Difficult to describe what to do



Fitts' Law



Fitts' Law

$$T = a + b\log_2(D/S + 1)$$

a, b = constants (empirically derived)
D = distance
S = size

ID is Index of Difficulty = $\log_2(D/S+1)$

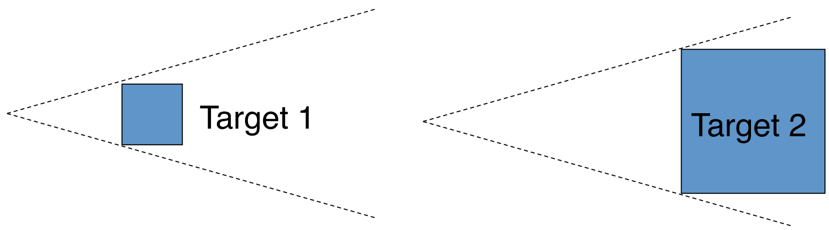
Models well-rehearsed selection task

T increases as the ***distance*** to the target increases

T decreases as the ***size*** of the target increases

Considers Distance and Target Size

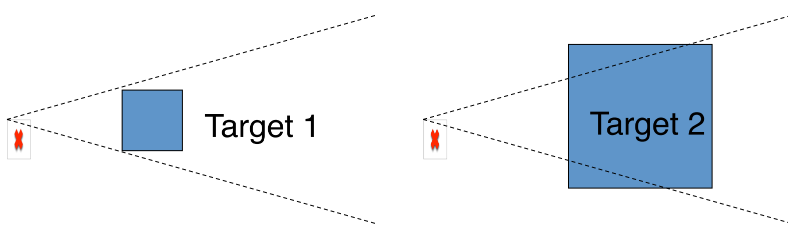
$$T = a + b\log_2(D/S + 1)$$



Same ID → Same Difficulty

Considers Distance and Target Size

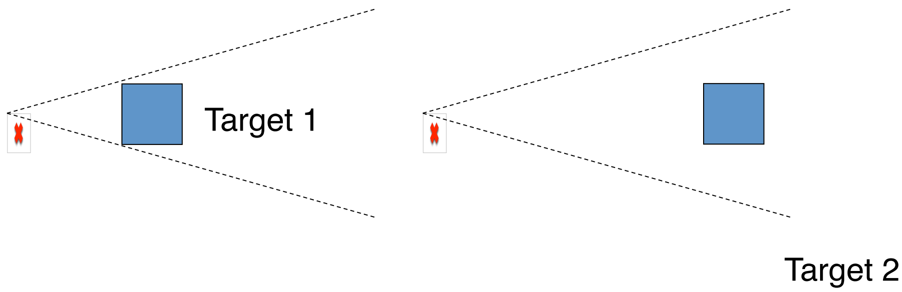
$$T = a + b\log_2(D/S + 1)$$



Smaller ID → Easier

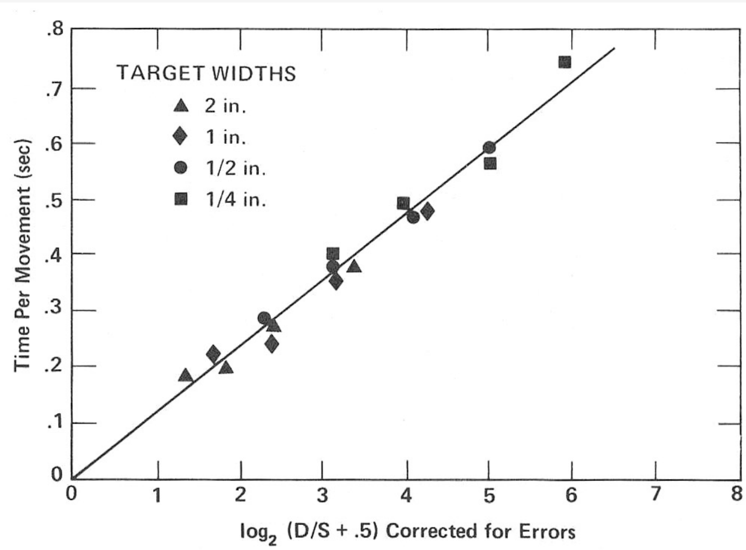
Considers Distance and Target Size

$$T = a + b\log_2(D/S + 1)$$



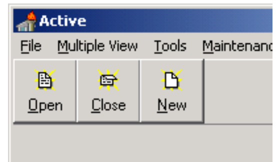
Larger ID → Harder

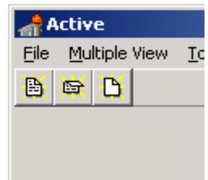
Experimental Data



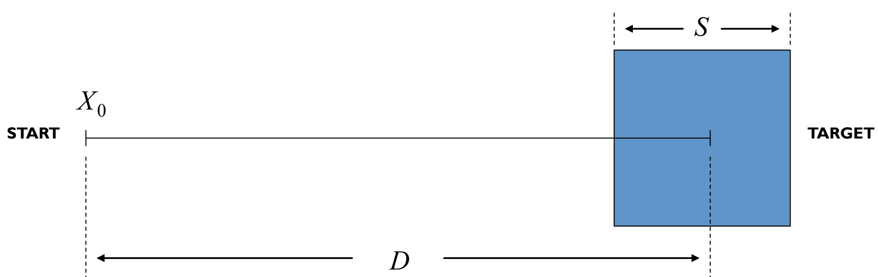
Toolbar Example

Microsoft Toolbars offer the user the option of displaying a label below each tool. Name at least one reason why labeled tools can be accessed faster. (Assume, for this, that the user knows the tool.)





Extend Fitts' Law to 2D Targets?



Summary

Decision Making and Learning

Time to make decisions depends on number of options

Choosing a movie at Blockbuster

Learning follows a power law

You get faster as you practice

Fitts' Law

Models movement time to select target

Time depends on distance and size of target

Input Devices

Questions:

What (low-level) tasks are the users trying to accomplish with an input device?

How can we think about the space of possible input devices?

What interaction techniques are encouraged/ discouraged by a particular device?

Important Tasks

Text Entry

Pointing/Marking

- Target acquisition
- Steering / positioning
- Freehand drawing
- Drawing lines
- Tracing and digitizing
- …

Text Entry: Keystroke Devices

Array of Discrete Inputs

Many variants of form and key layout

Can be one-handed or two

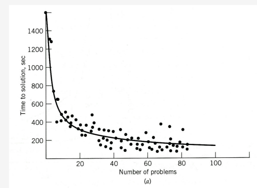
Wide range of sizes

Two-hand full keyboard is relatively standardized, Less standardization on others: Command keys, generic function keys, cursor movement, numeric keypad,...

Take advantage of procedural memory

Power law of practice

$$T_n = T_1 n^{-a} + c$$



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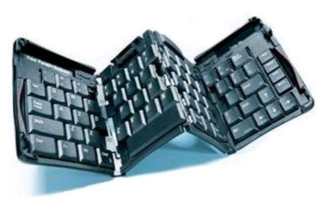
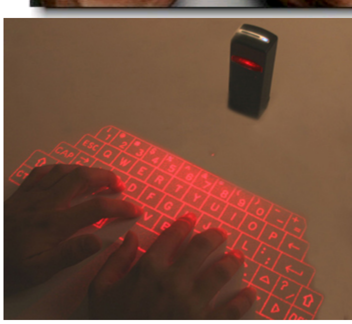
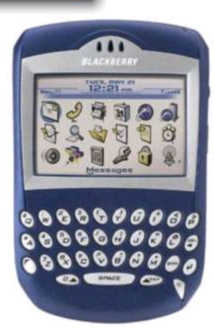
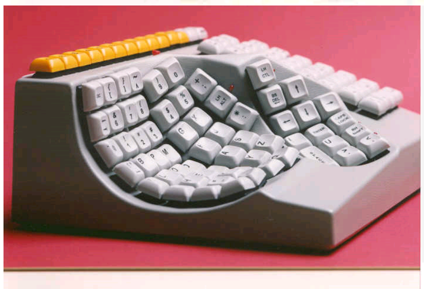
Keyboards

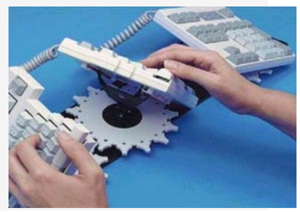







Maxim





Key Layouts


QWERTY
Q W E R T Y U I O P
A S D F G H J K L
Z X C V B N M
DVORAK
P Y F G C R L
A O E U I D H T N S
Q J K X B M W V Z