Introduction to Computer Input Devices and Their Evaluation

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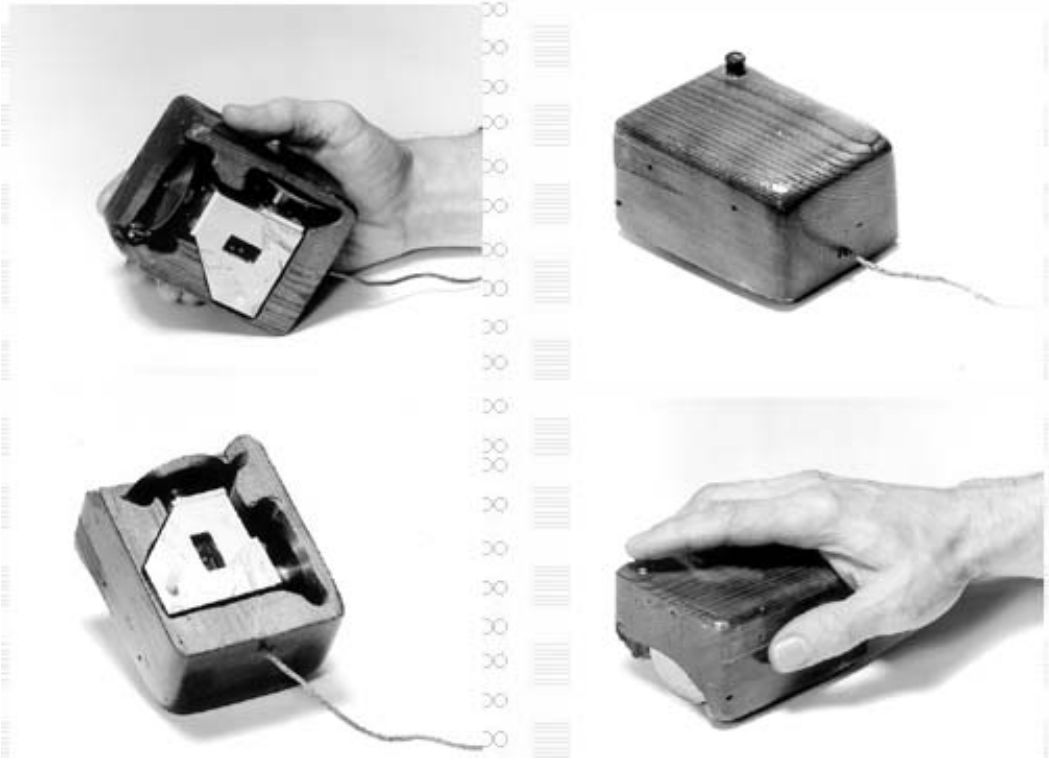
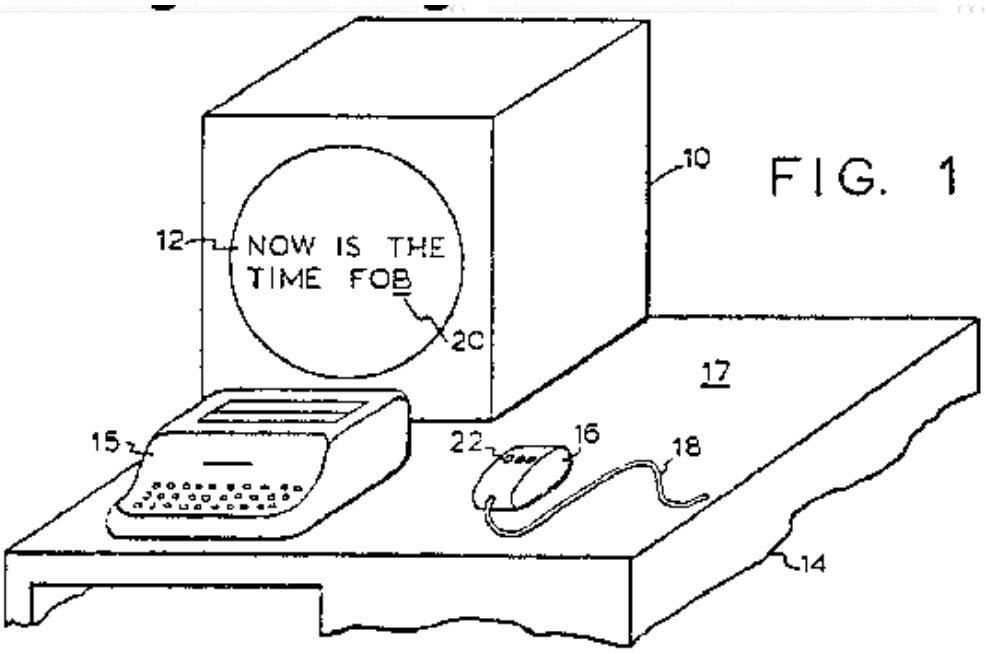
First Mouse (Douglas Engelbart and William English, 1964)



First Mouse Patent (Engelbart)



"A Research Center for Augmenting Human Intellect," Douglas C. Engelbart, and William K. English, *Proc. 1968 Fall Joint Computer Conference*

A Variety of Input Devices

Mouse

Stylus

Touchscreen

Touchpad

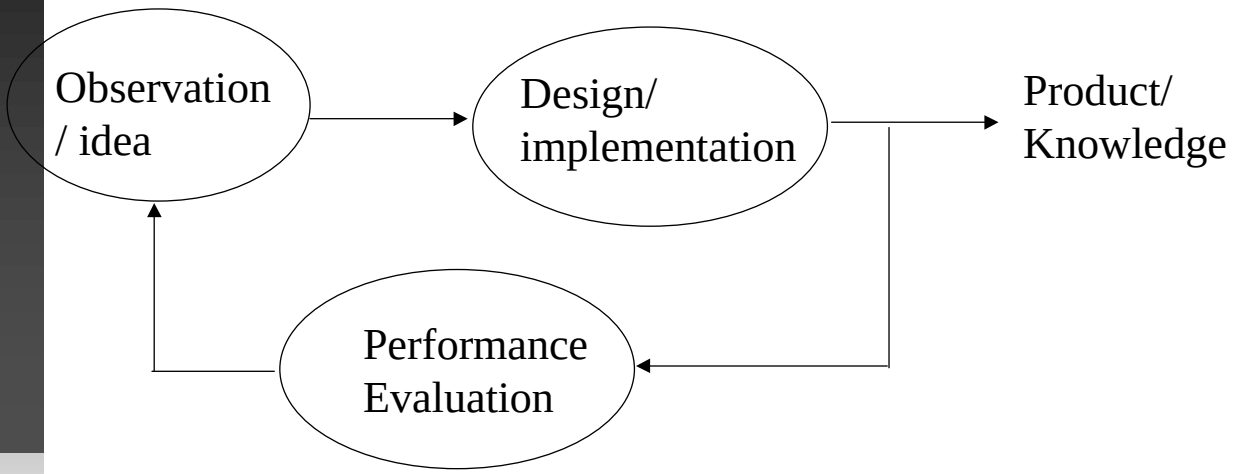
Joystick

...

Performance Evaluation

- *"I like it!" / "It is cool!" is not enough*
  - *"Perception is not always reality"*
  - *Conscious articulation is not always behavior (describe how to ride a bike)*
- *Individual differences*
- *Making HCI an empirical (good) science*

Iterative Design



- Evaluation for insights
- Evaluator vs. designer

Qualitative Analysis

Touchscreen

- *Pros*
- *Cons*

Stylus / light pen

- *Pros*
- *Cons*

Quantitative Performance Evaluation

What to measure?

- *Depending on the task / application scenario*

Common measures

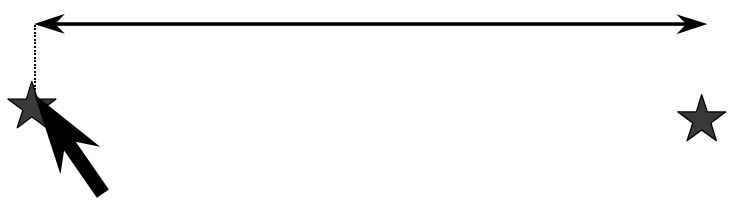
- *Trial completion time*
- *Error rate*
- *Learning speed*
- *Comfort / fatigue*
- *etc.*

Pointing Device Evaluation

Real task: Interacting with WIMP interface

Experimental task: target acquisition

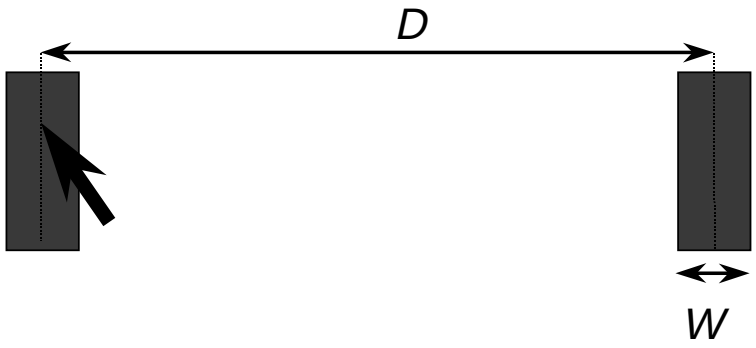
- *abstract, elemental, essential*



Performance measures: time, error rate

Fitts' law (Paul Fitts, 1954)

- $MT = a + b \underbrace{\log_2(\frac{D}{W} + 1)}_{ID}$

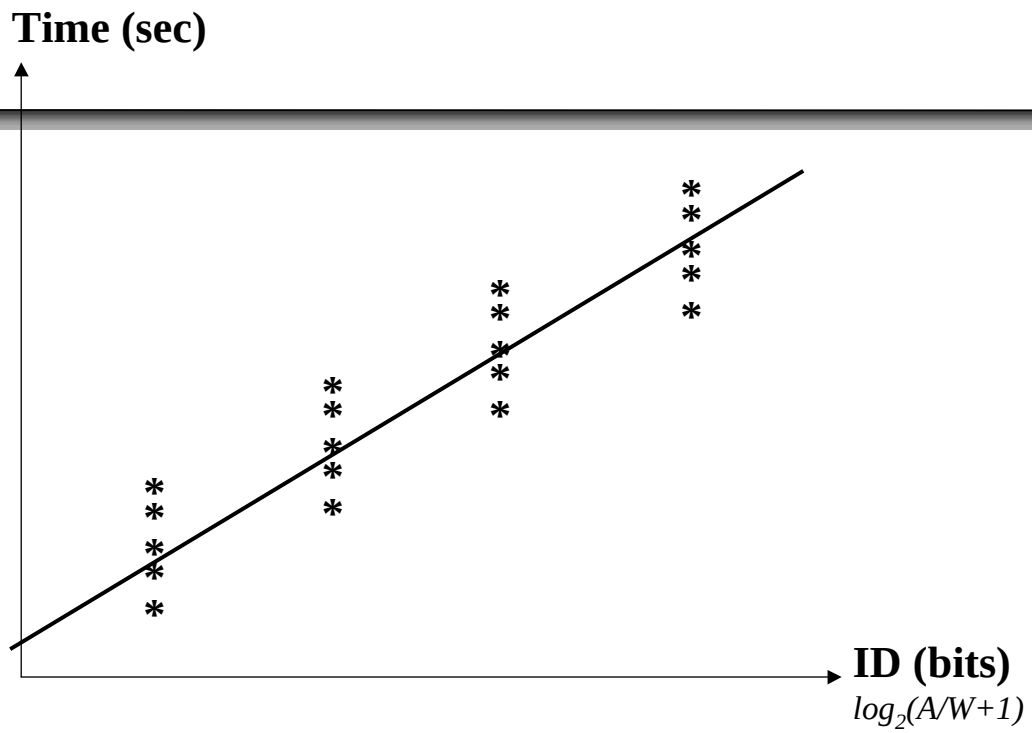


1/b - Index of Performance, Throughput, Bandwidth

Fitts' law

- "The information capacity of the human motor system in controlling the amplitude of movement",

  Journal of Experimental Psychology, *vol 47, 381-391*



Experimental Design

- *Fairness for the given task*
- *Wide enough ID combinations*
  - *W's: from character size (10) to icon (30 pixel)*
  - *A's: from short (60) to cross screen (800)*
- *Multiple individuals/subjects*
- *Balancing orders*
- *Statistical analysis*
- *Controlling error (about 5%)*

A B
B A

A B C
B C A
C A B

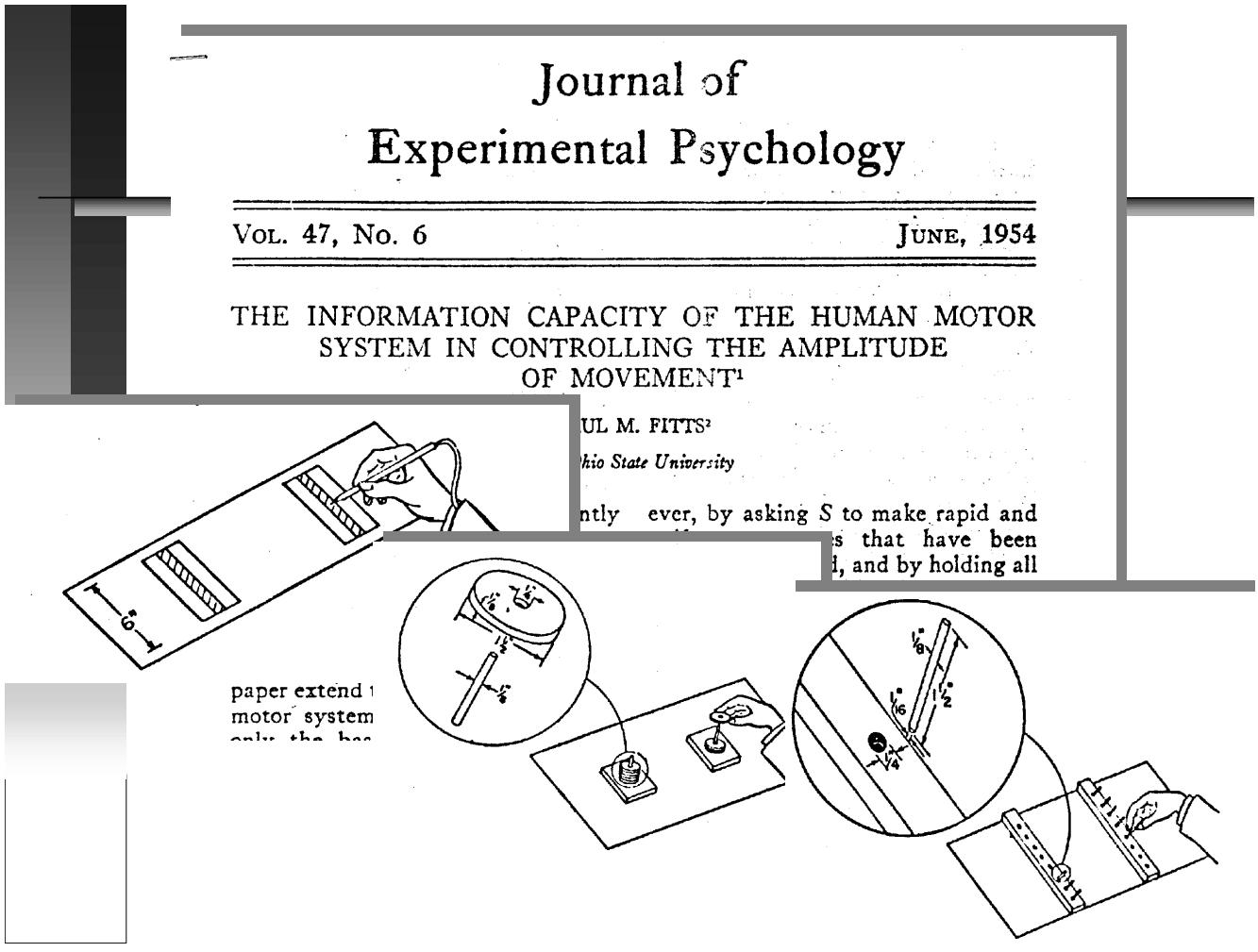
Task modeling for evaluation

Bring task modeling to device evaluation

- *Card, English, Burr, 1978*

"Evaluation of mouse, rate controlled isometric joystick, step keys and text keys for text selection on a CRT",

Ergonomics, vol. 21, 601-613



Journal of
Experimental Psychology

VOL. 47, No. 6 JUNE, 1954

THE INFORMATION CAPACITY OF THE HUMAN MOTOR SYSTEM IN CONTROLLING THE AMPLITUDE OF MOVEMENT[1]

UL M. FITTS[2]

hio State University

ntly ever, by asking S to make rapid and
s that have been
l, and by holding all

paper extend
motor system

Beyond Fitts' law

- *Hick's law*
- *Key stroke model*
- *Control theoretic modeling*
- *Limitations to Fitts law: pointing only*

Trajectory-based tasks

- *Example: hierarchical menus*
- *Is there a "law" to Steering?*

Thought experiment...

2 goals passing

$$ID = \log_2 \left(\frac{A}{W} + 1 \right)$$

3 goals passing

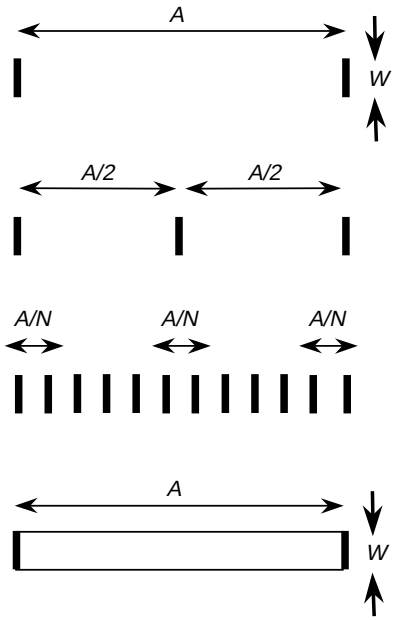
$$ID = 2 \log_2 \left(\frac{A}{2W} + 1 \right)$$

N+1 goals passing

$$ID = N \log_2 \left(\frac{A}{NW} + 1 \right)$$

∞ goals passing

$$ID = \frac{A}{W} ?$$



"Steering law"

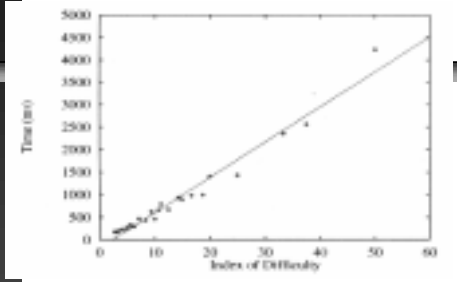
Steering law (Accot and Zhai 1997)

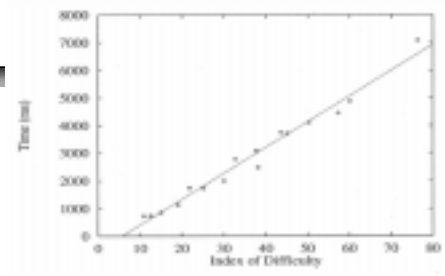
- "Beyond Fitts' law: Modeling trajectory based HCI tasks", *Proc of CHI'97*

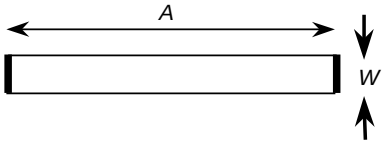
$$T_C = a + b\, ID_C$$

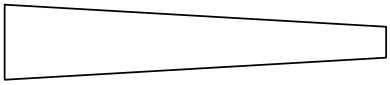
$$ID_C = \int_C \frac{dx}{W(x)}$$

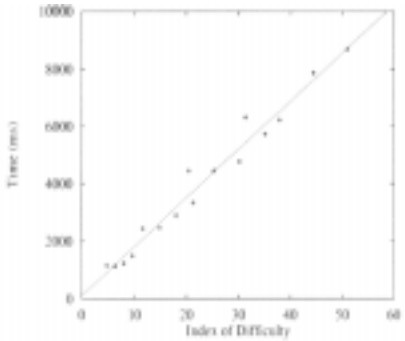
Results





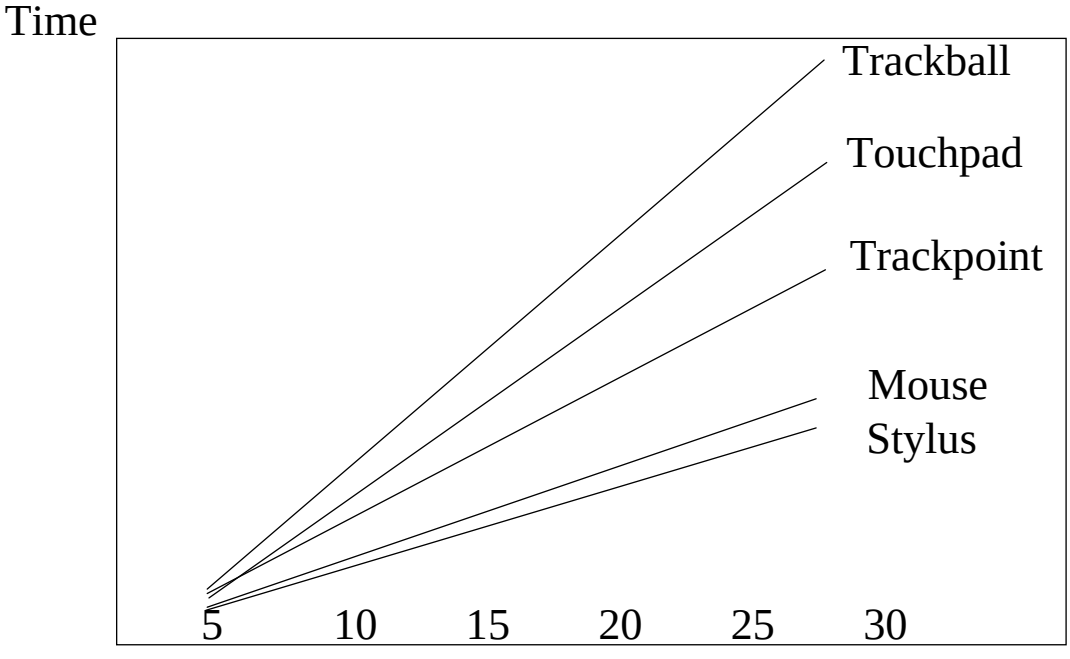






Device comparison in steering tasks

(Accot & Zhai, CHI'99)



Conferences and Journals

- *CHI: ACM Conference on Human Factors in Computing Systems*
- *INTERACT: IFIP Conference on Human Computer Interaction*
- *UIST: ACM Symposium on User Interface Software and Technology*
- *HFES: Human Factors and Ergonomics Annual Meeting*

- *ACM Transactions on Computer Human Interaction (TOCHI)*

Lab Assignment

- *Measure Fitts' law index of performance with bare hand on paper*
- *Measure any two devices using Fitts' law with the Almaden Program*
- *Compare performance of the two devices*
- *Compare devices with bare hand*
- *Discuss the validity/benefits of Fitts' law in your study.*
- *Discuss pros and cons of the devices: suggest improvements or new designs*