Introduction to Computer Input Devices and Their Evaluation

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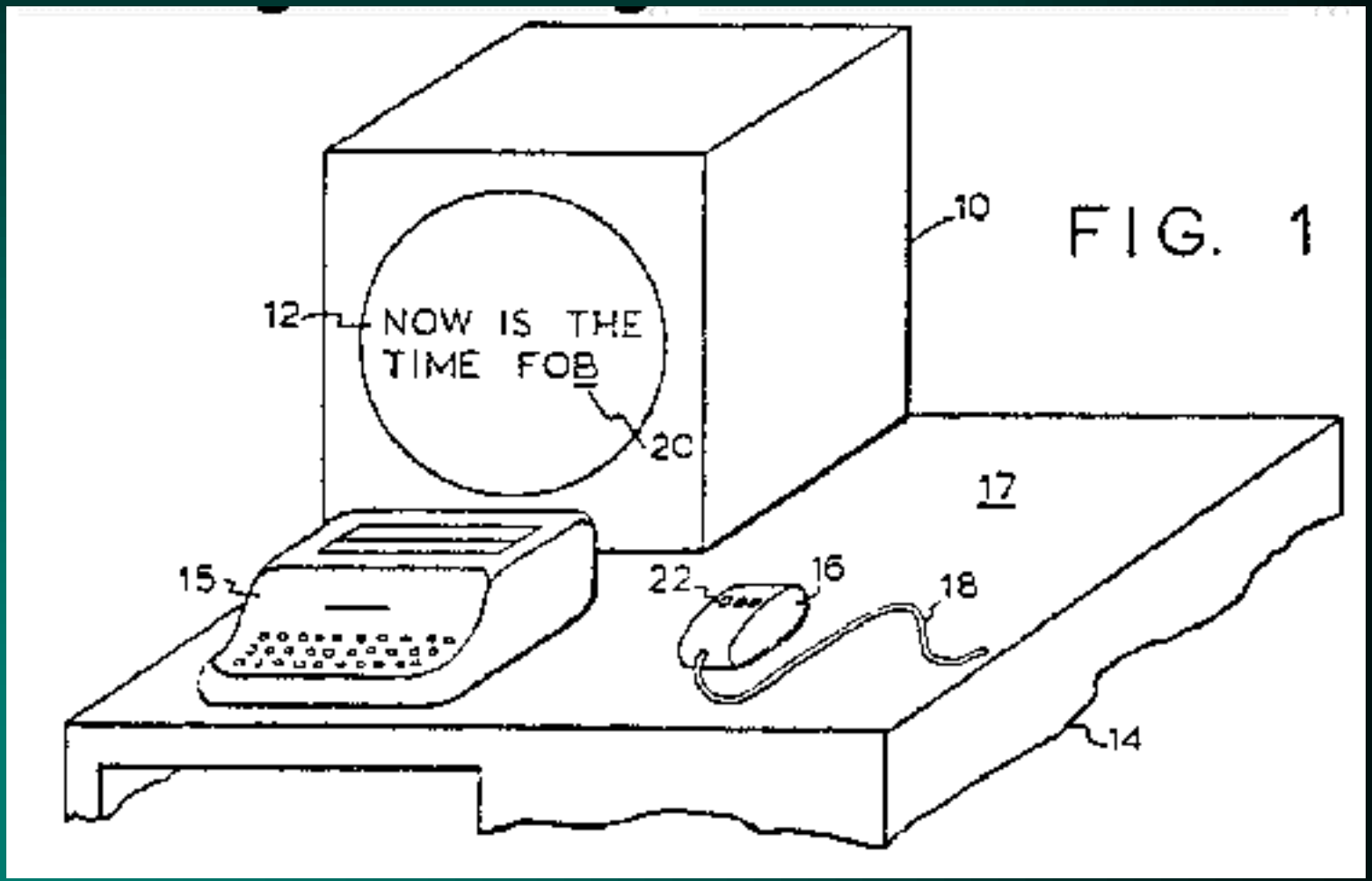
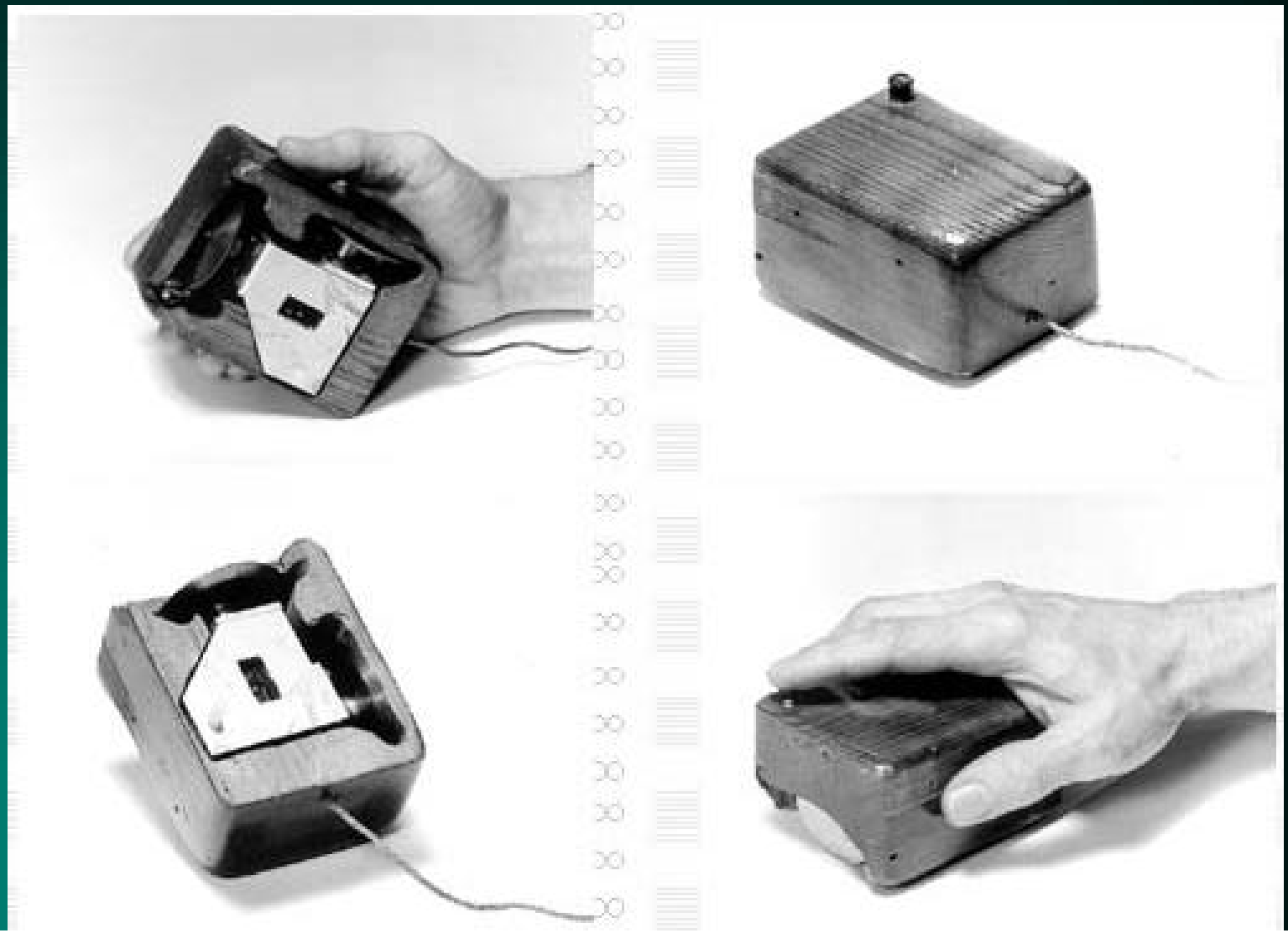
First Mouse Patent (Engelbart, 1964)



First Mouse (Douglas Engelbart and William English, 1964)



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

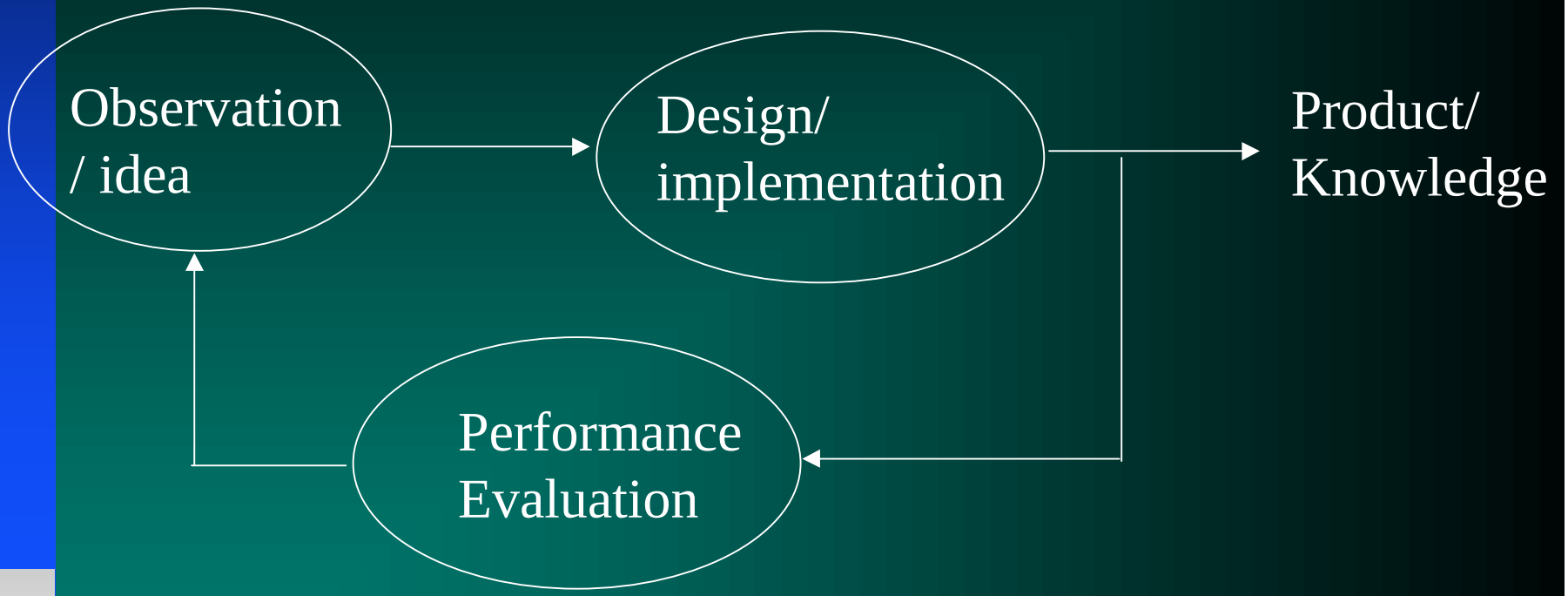
A Variety of Input Devices

- 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)*
- *Complexity of human behavior/performance beyond analyses*
- *Individual differences*
- *Objectivity*
- *Making HCI an empirical (good) science*
- *Iterative Design*

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*

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

Fitts' law (Paul Fitts, 1954)

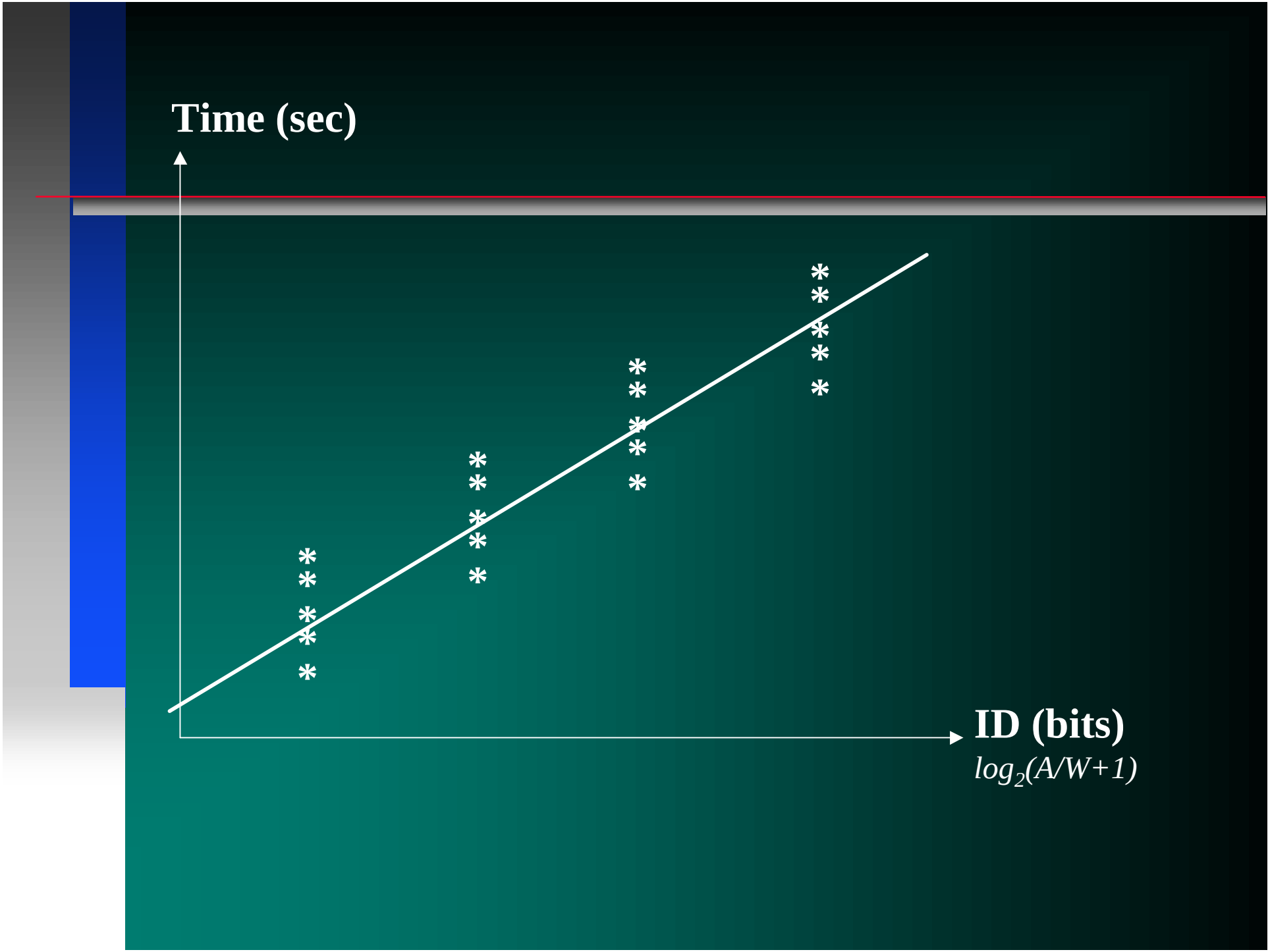
- $MT = a + b \underbrace{\log_2(\frac{D}{W}+1)}_{ID}$

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*


Time (sec)
ID (bits)
$log_2(A/W+1)$

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

Journal of
Experimental Psychology

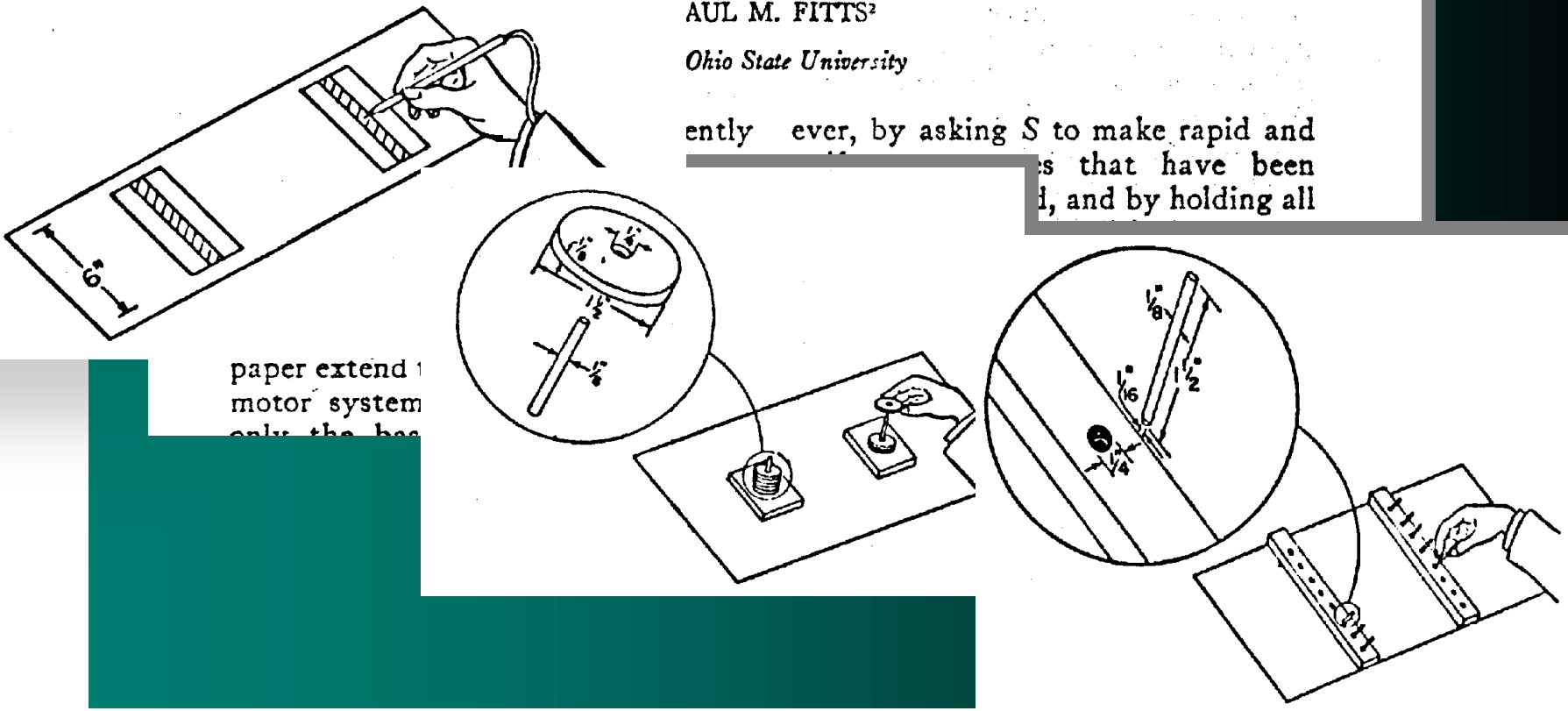
VOL. 47, No. 6 JUNE, 1954

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

PAUL M. FITTS[2]
Ohio State University

ently ever, by asking *S* to make rapid and
s that have been
d, and by holding all

paper extend
motor system



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*

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*

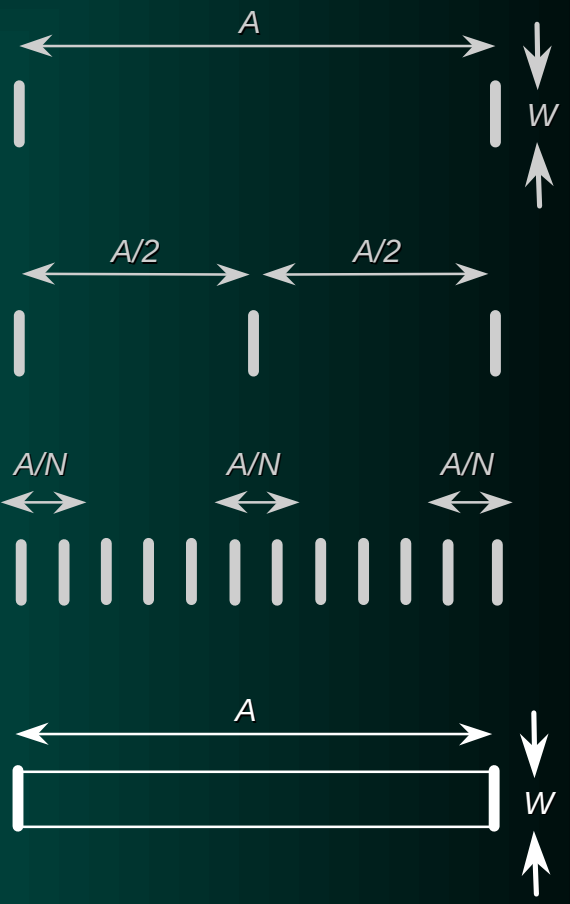
$$ID = 2 \log_2 \left(\frac{A}{2W} + 1 \right)$$

- *N+1 goals passing*

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

- *¥ goals passing*

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



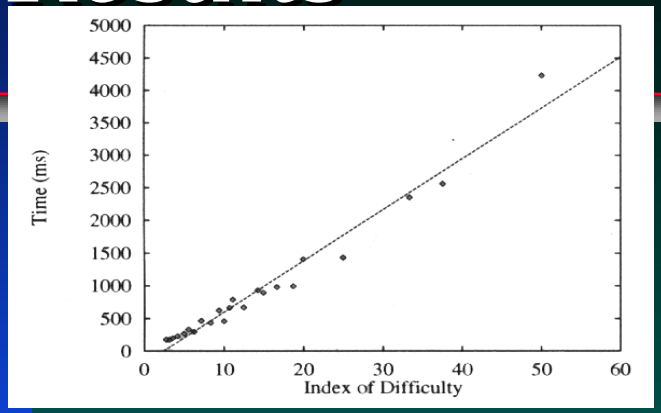
"Steering law"

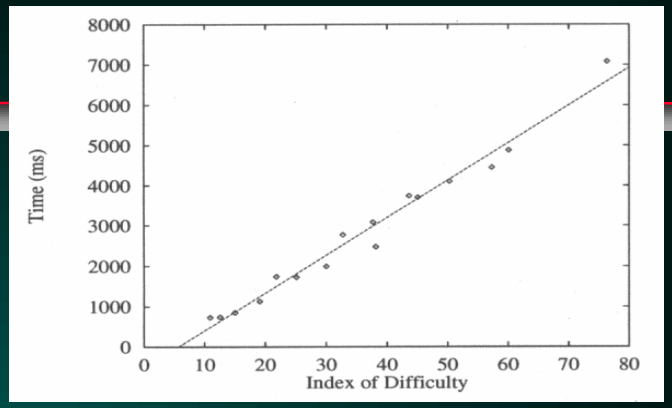
- *Steering law (Accot and Zhai 1997)*
  - "Beyond Fitts' law: Modeling trajectory based HCI tasks", *Proc of CHI'97*

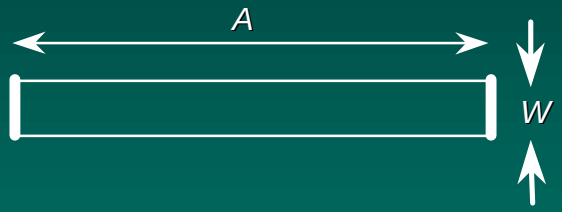
$$T_C = a + b\, ID_C$$

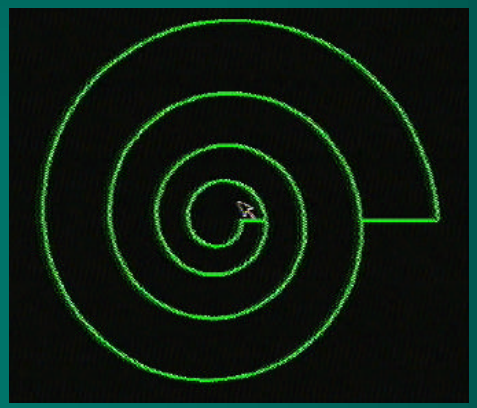
$$ID_C = \int_C \frac{dx}{W(x)}$$

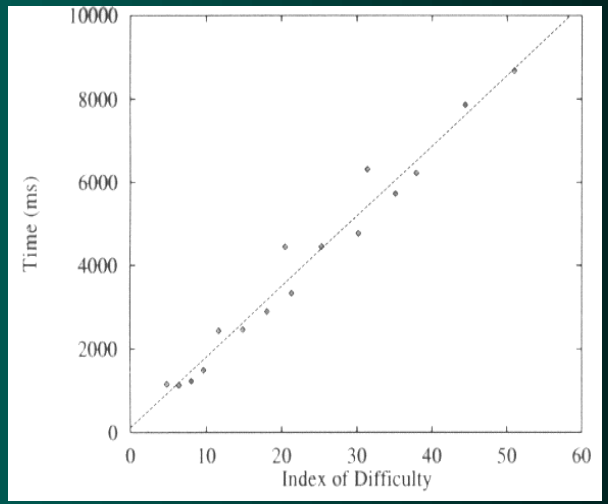
Results


Time (ms)
Index of Difficulty
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
0
10
20
30
40
50
60

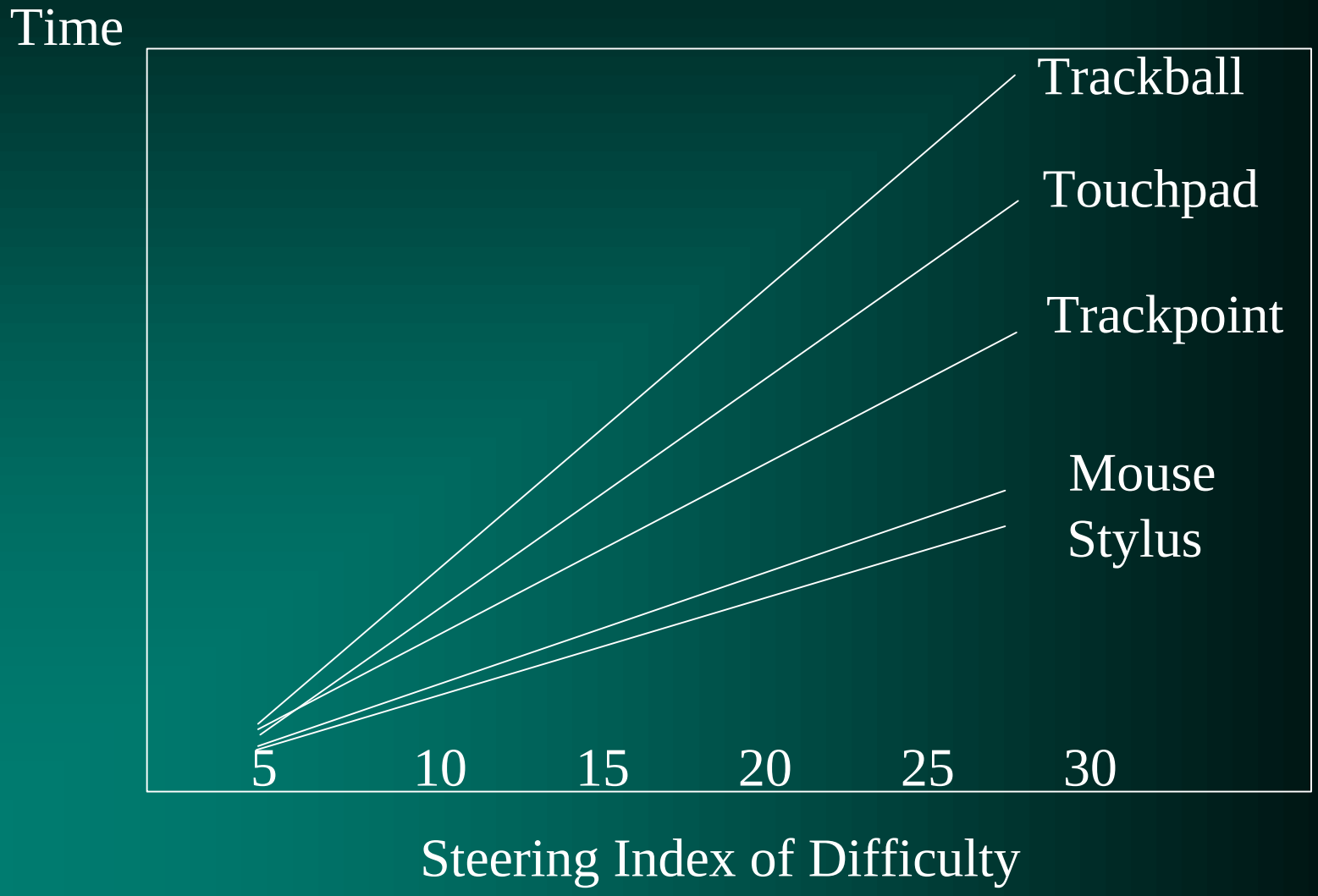

Time (ms)
Index of Difficulty
0
1000
2000
3000
4000
5000
6000
7000
8000
0
10
20
30
40
50
60
70
80


A
W




Time (ms)
Index of Difficulty
0
2000
4000
6000
8000
10000
0
10
20
30
40
50
60

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)*