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User Interaction COMPSCI2031

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Recap: What we did last yesterday

- Don Norman's Design Principles
- User-Centered Design
- Don Norman Design Task
- Optional Reading: Don Norman Design Book

Design Theory Quiz Example

According to Don Norman's design principles, what does the term "signifier" refer to in the context of design?

A) The physical limitations of an object

B) The possible actions an object suggests

C) A visual or auditory cue that communicates how to use an object

D) The cultural norms that influence how an object is used

UCD Quiz Example

When introducing user-centered design (UCD) into an organization, which of the following challenges is often encountered?

A. Struggling to integrate UCD with agile methodologies due to conflicting principles.

B. Difficulty in standardizing design aesthetics across different platforms.

C. Balancing the need for rapid product development with the time required for UCD iterations.

D. Challenges in automating the UCD process to reduce manual effort.

- Quiz:
  - Closed book
  - Multiple choice
    - 1 answer correct: +100%
    - Per incorrect answer: -33.3%
  - Moodle quiz
  - Quiz questions ask for basic understanding of concepts from lectures → see yesterday's example questions
- Exam
  - Open book → paper notes only
  - Exam questions tend not ask for definitions etc but instead put what we have learned into practice (apply/transfer) → See previous exam.

University policy. We cannot change this.

User Interaction Topics

- ✅ HCI History and Introduction
- ✅ Usability and Heuristics
- ✅ Heuristic Evaluation and Human Cognition
- ✅ Human Perception and Capabilities
- ✅ Experimental Design & Variables Research
- ✅ Personas and Scenarios
- ✅ Surveys in HCI
- ✅ Ethnography
- ✅ Statistical Methods
- ✅ Theories in HCI & User-Centered Design
11. Models of Interaction & A/B testing.
12. Large Scale and Mobile HCI
13. Various Users and Ethics
14. Revision & Example Exams & Quiz

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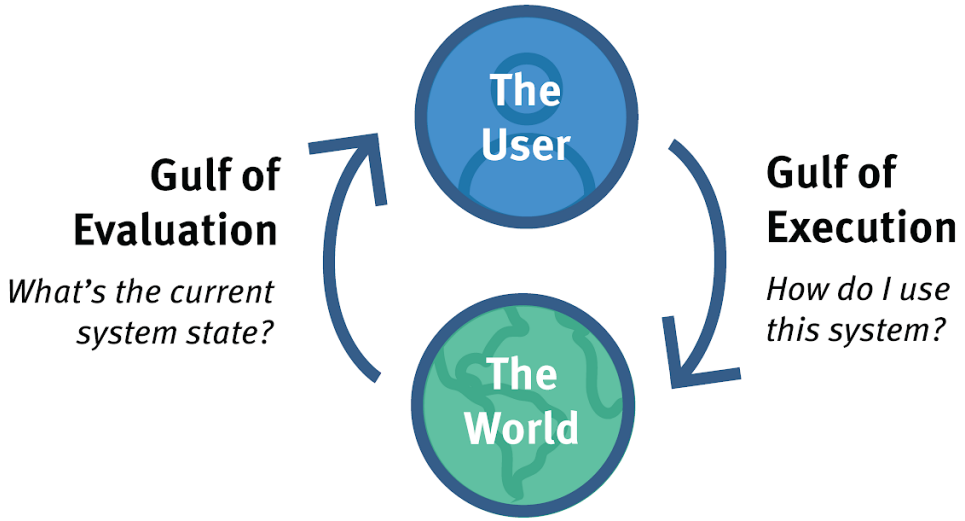
Models of Interaction

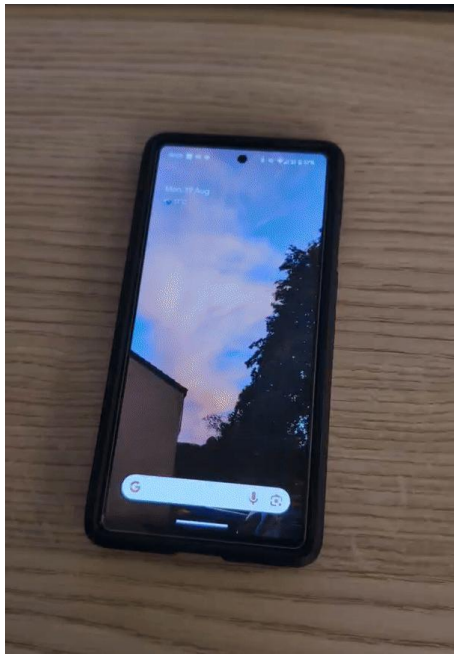
Lecture 11

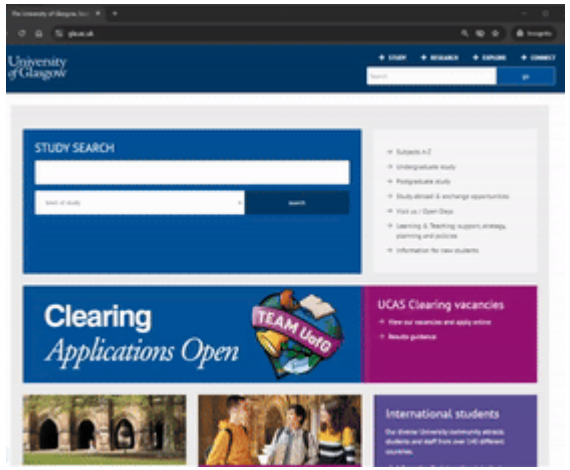
Models of Interaction in HCI

- Models of interaction are looking at two parts of a loop
- Goal: improve this loop
- How? → New interaction methods and models of measuring this loop



Measure? Target acquired!





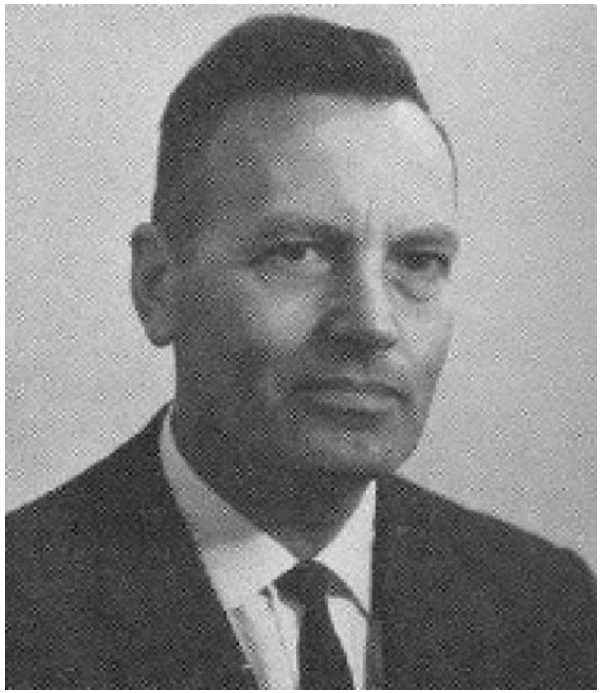
How much time do we need to move our finger/mouse/pointer to a target?

Let me present: Paul Fitts! (and his law)


APA CENTENNIAL FEATURE

The Information Capacity of the Human Motor System in Controlling the Amplitude of Movement

Paul M. Fitts
Ohio State University



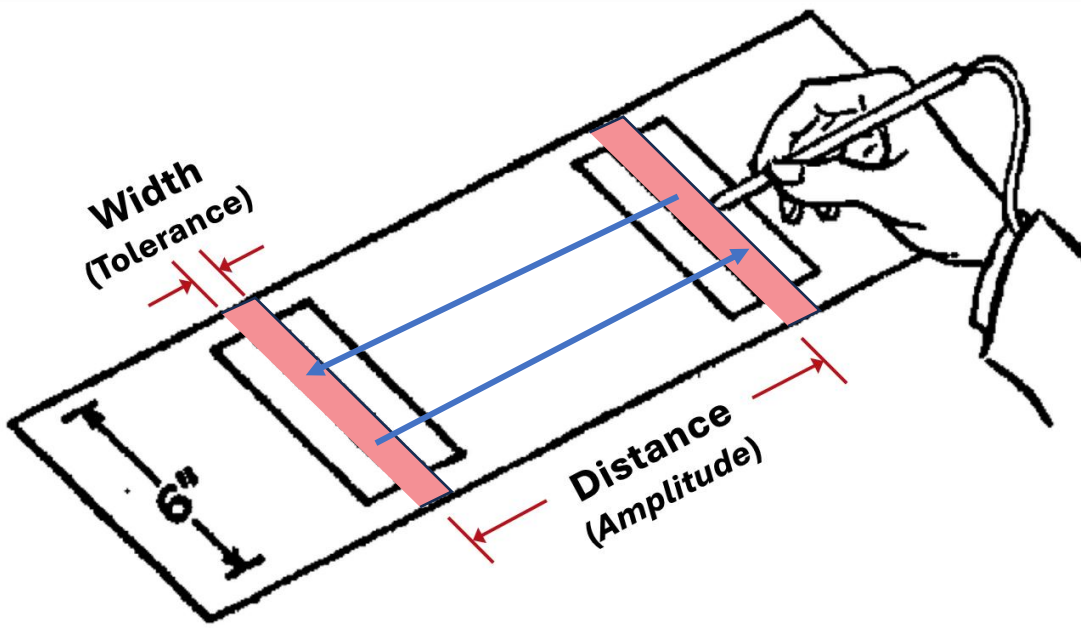
$$MT = a + b * log_2\left(\frac{2D}{W}\right)$$

Movement Time

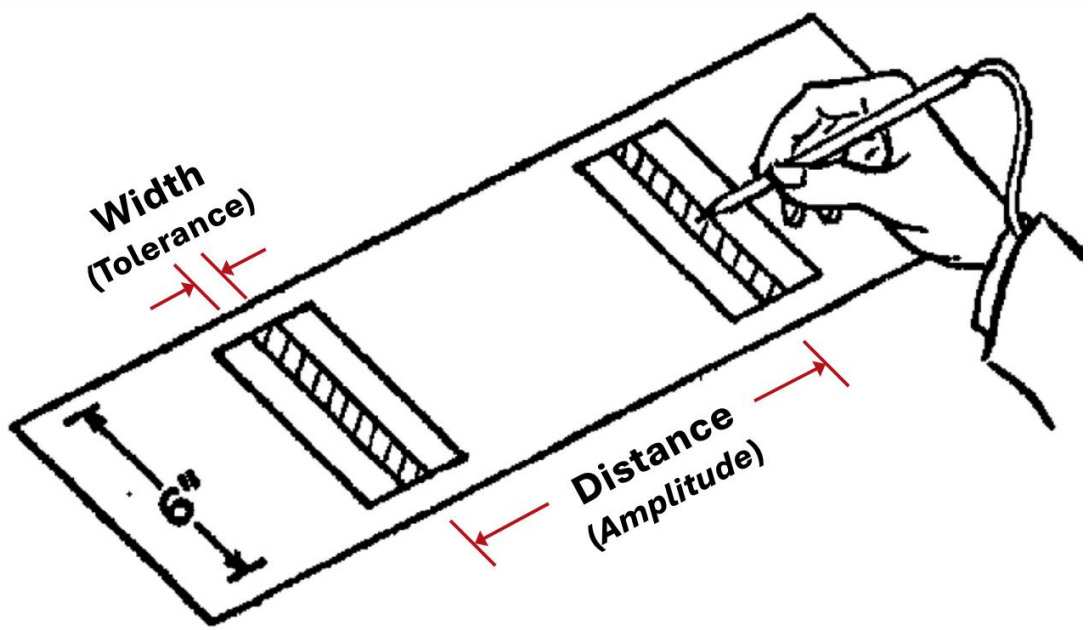
Fitts, P. M. (1954). The information capacity of the human motor system in controlling the amplitude of movement. *Journal of Experimental Psychology, 47*(6), 381–391. https://doi.org/10.1037/h0055392

Fitts' Experiment

- Four distances: 2, 4, 8, 16 in
- Four widths: 0.25, 0.5, 1, 2 in
- 16 combinations

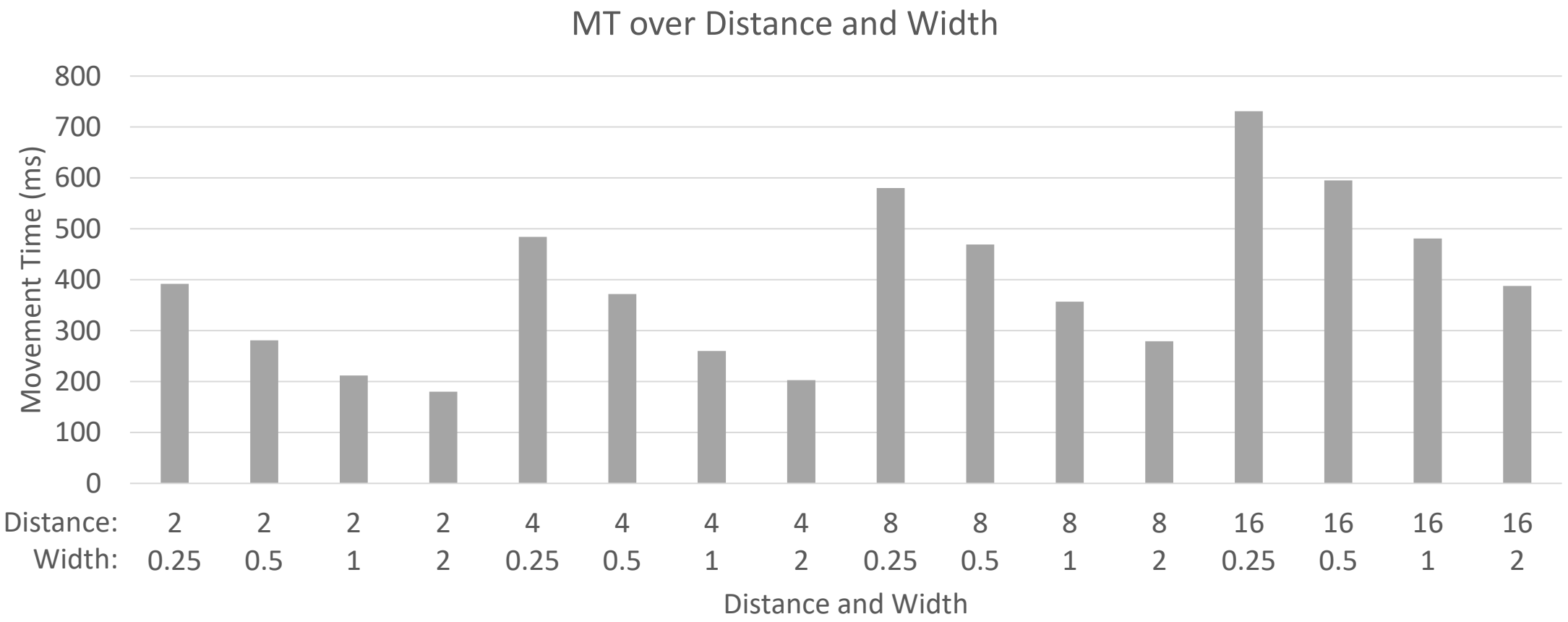


A lot of measurements…

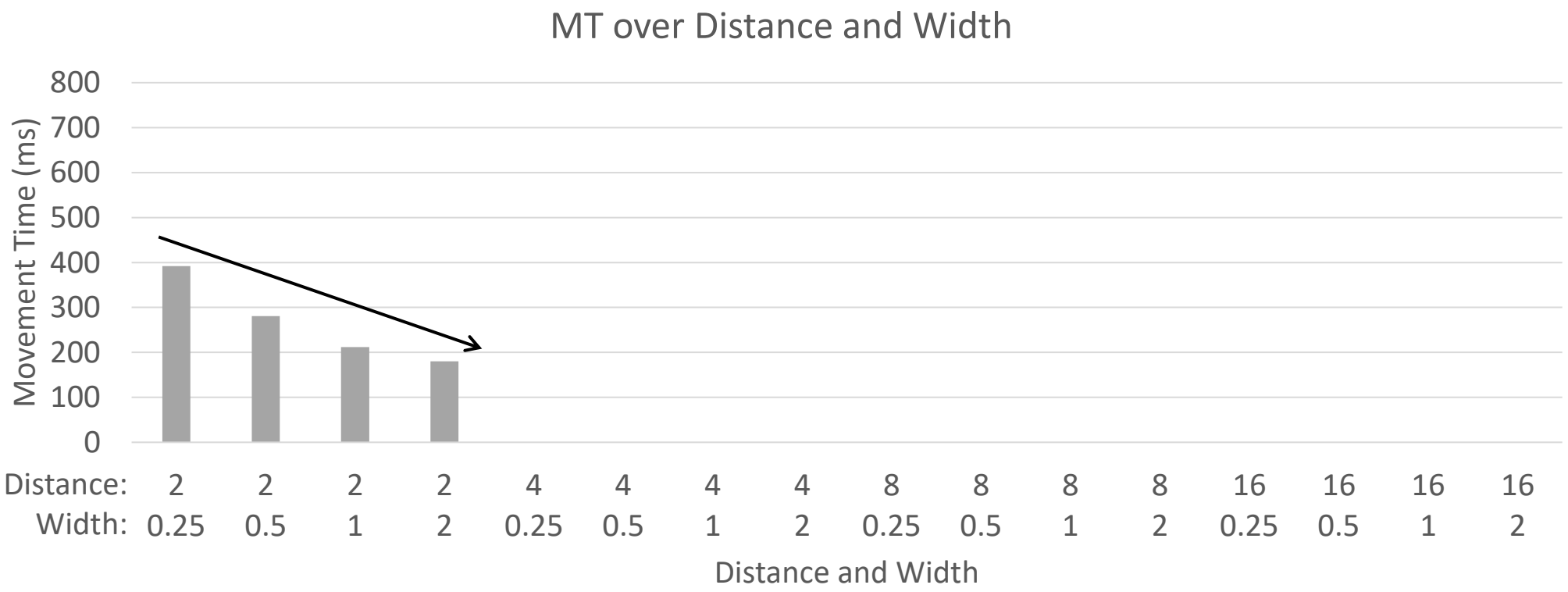


Distance	Width	MT [ms]
2	0.25	392
2	0.5	281
2	1	212
2	2	180
4	0.25	484
4	0.5	372
4	1	260
4	2	203
8	0.25	580
8	0.5	469
8	1	357
8	2	279
16	0.25	731
16	0.5	595
16	1	481
16	2	388

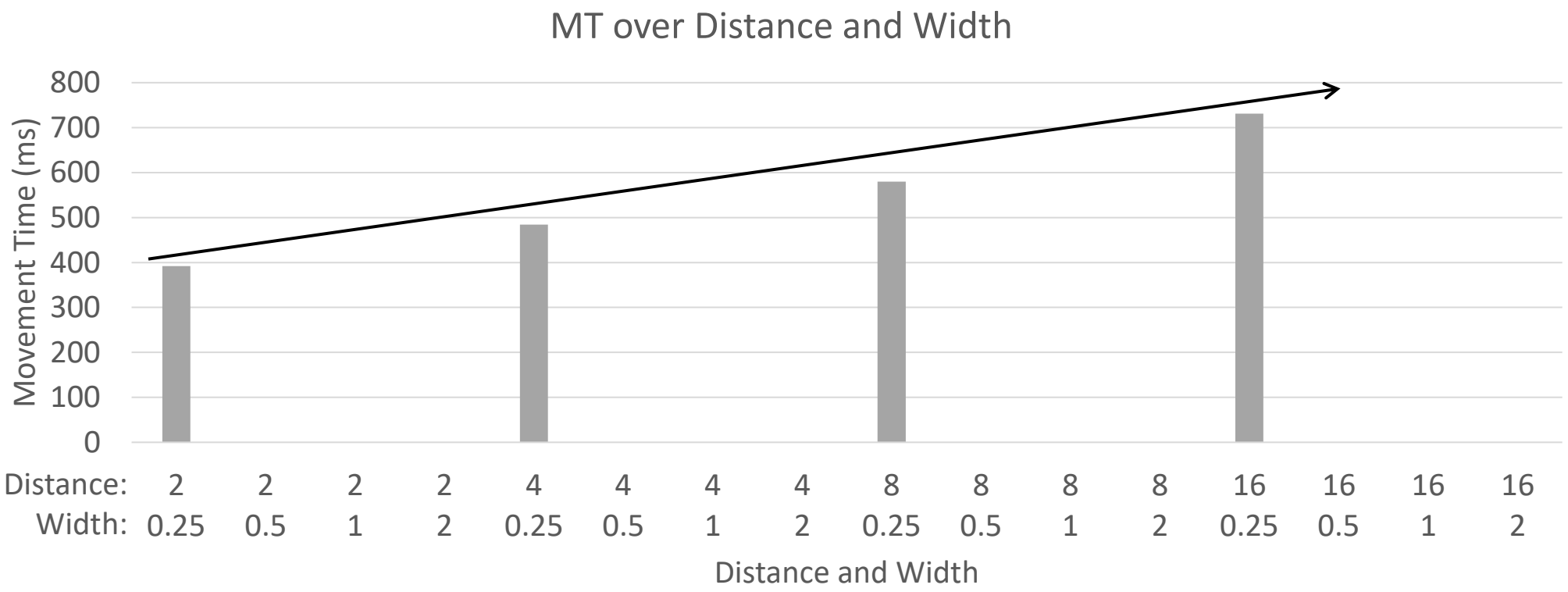
… some nice figures!



Larger target width? We're faster!



Longer distance? We're slower!

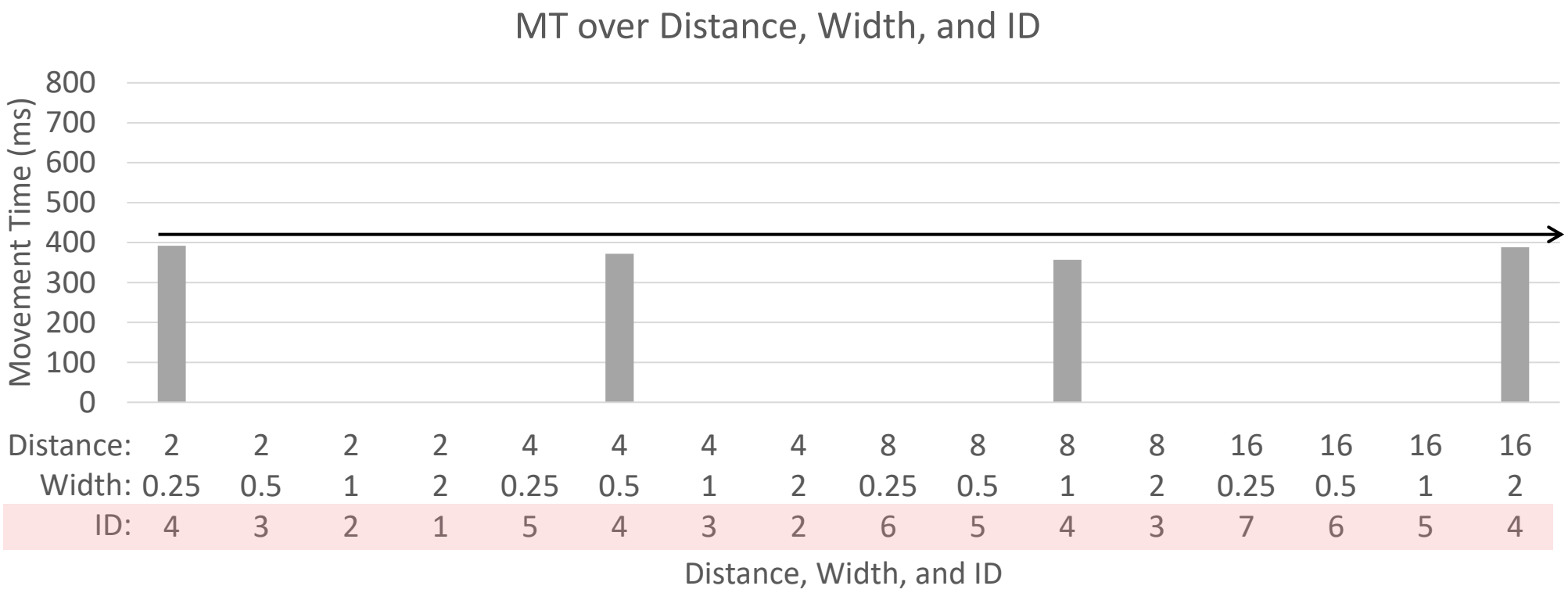


Index of Difficulty

- $MT = a + b * log_2\left(\frac{2D}{W}\right)$
- With $log_2\left(\frac{2D}{W}\right) = ID$

Distance	Width	ID	MT
2	0.25	4	392
2	0.5	3	281
2	1	2	212
2	2	1	180
4	0.25	5	484
4	0.5	4	372
4	1	3	260
4	2	2	203
8	0.25	6	580
8	0.5	5	469
8	1	4	357
8	2	3	279
16	0.25	7	731
16	0.5	6	595
16	1	5	481
16	2	4	388

Different width, different distance, and same ID = same time!



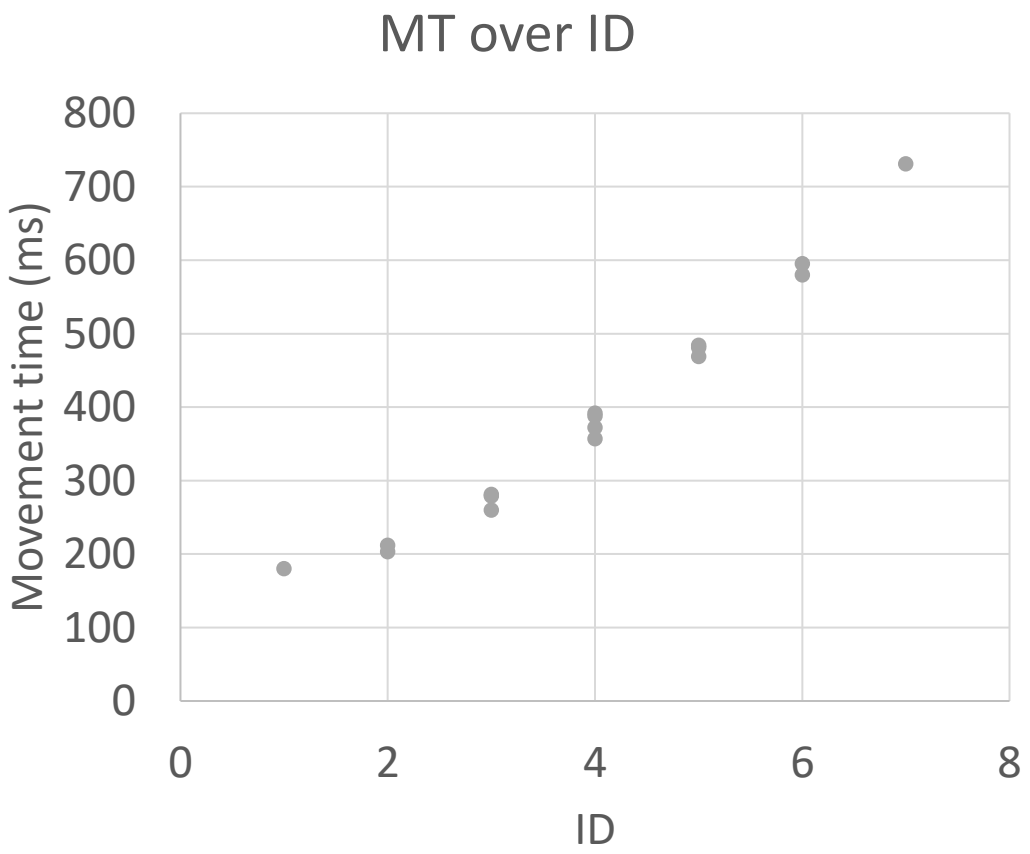
Deconstructing Fitts Law – part II.

ID is a property of the movement task, measured in *bits*

$$MT = a + b * log_2\left(\frac{2D}{W}\right)$$

a & b via linear regression!

ID	MT
4	392
3	281
2	212
1	180
5	484
4	372
3	260
2	203
6	580
5	469
4	357
3	279
7	731
6	595
5	481
4	388



a & b via linear regression!

ID	MT
4	392
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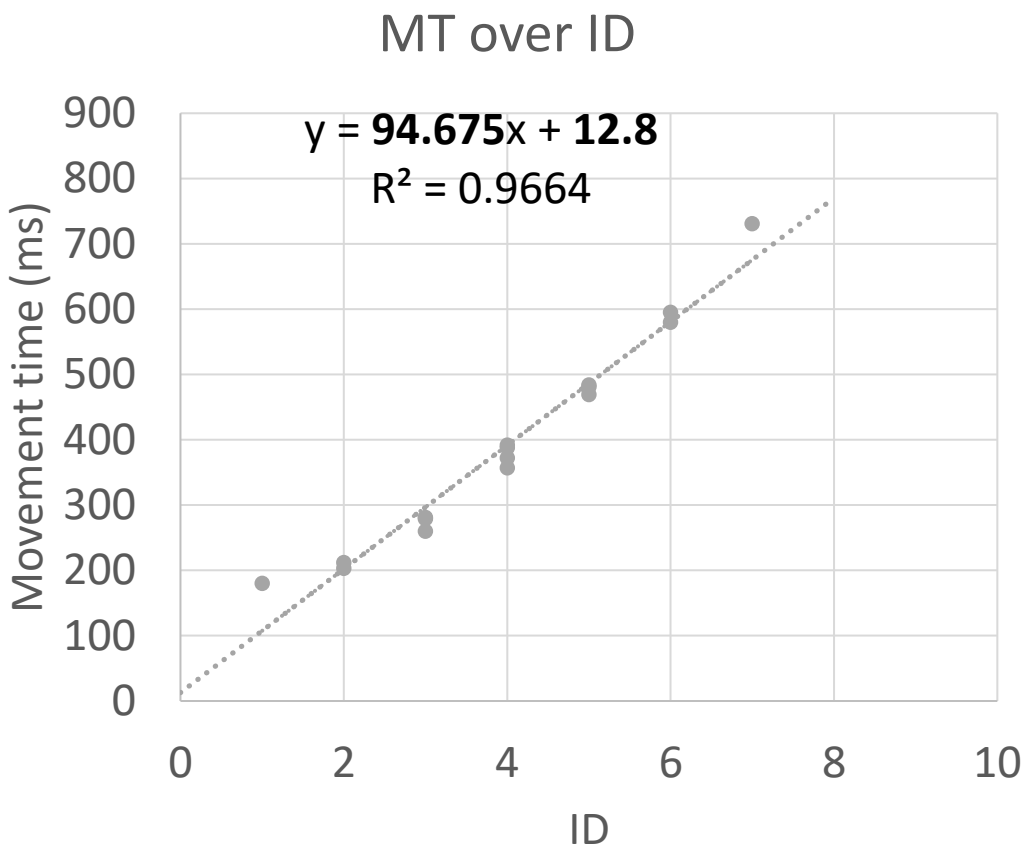


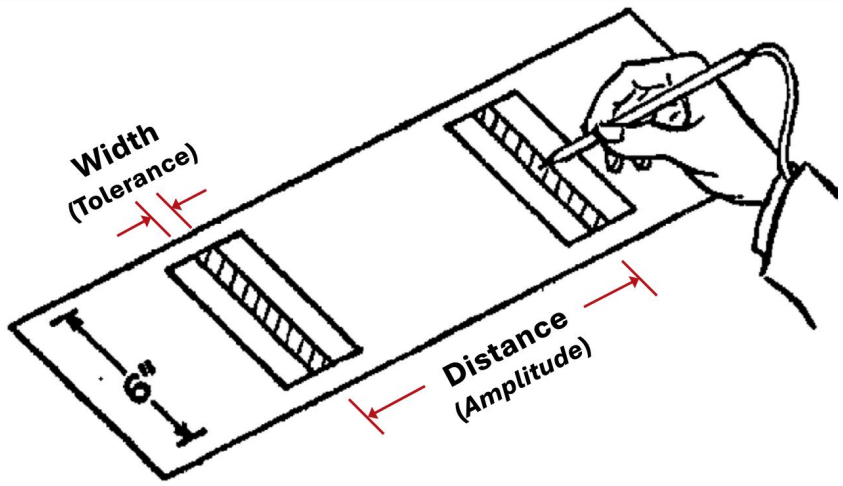
Slope and y-intercept!

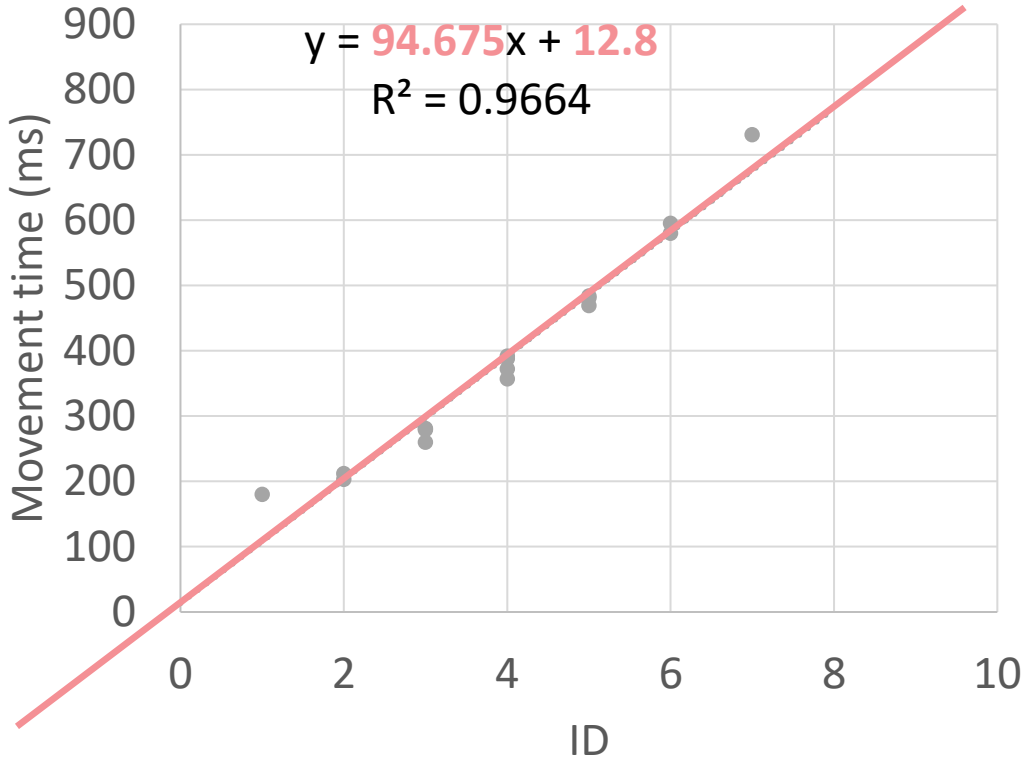
a = time constant, e.g. for preparing the movement, in *seconds*

b = rate at which movement time increases with task difficulty (*seconds/bit)*

$MT = a + b * ID$ with

- $a = 12.8$ (y-intercept)
- $b = 94.675$ (slope)





Deconstructing Fitts Law.

ID = difficulty of a target acquisition task based on distance to target and target size, measured in *bits*

$$MT = a + b * log_2\left(\frac{2D}{W}\right)$$

Deconstructing Fitts Law.

a = time constant, e.g. to initiate the movement, in *seconds*

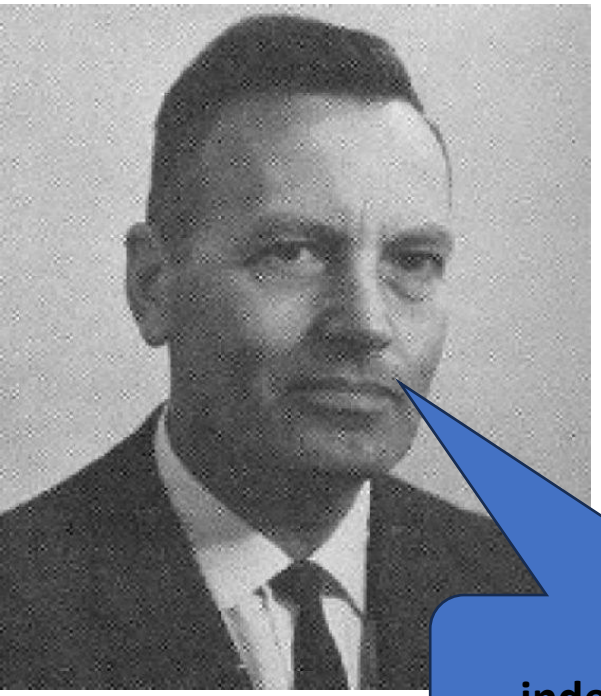
$$MT = a + b * log_2\left(\frac{2D}{W}\right)$$

Deconstructing Fitts Law.

b = how much additional time is required as ID increases (*seconds/bit).*

$$MT = a + b * log_2\left(\frac{2D}{W}\right)$$

Deconstructing Fitts Law.



$$MT = a + b * log_2\left(\frac{2D}{W}\right)$$

independent of the device

Deconstructing Fitts Law.

device-dependent (on the body part and/or device)

$$MT = a + b * log_2\left(\frac{2D}{W}\right)$$

Deconstructing Fitts Law.

a = time constant, e.g. to initiate the movement, in *seconds*

b = how much additional time is required as ID increases (*seconds/bit)*.

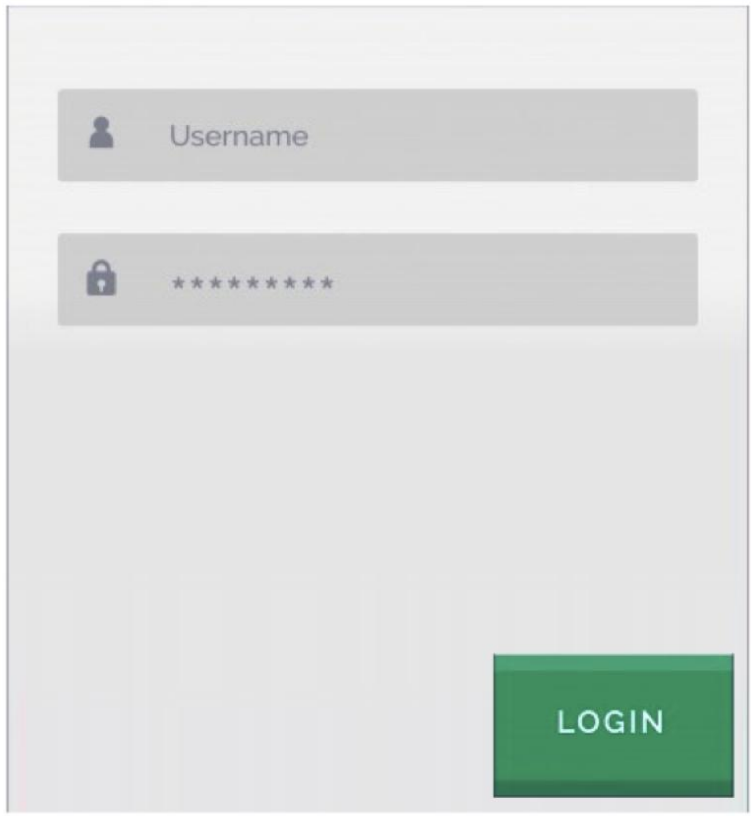
ID = difficulty of a target acquisition task based on distance to target and target size, measured in *bits*

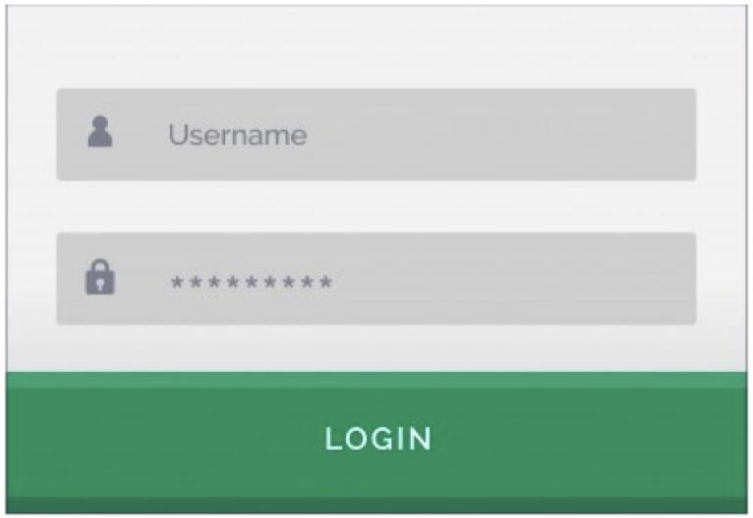
$$MT = a + b * log_2\left(\frac{2D}{W}\right)$$

device-dependent, on the body part and/or device

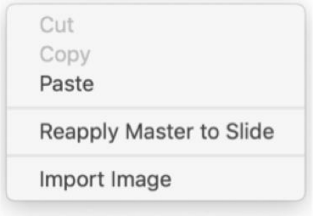
independent of the device

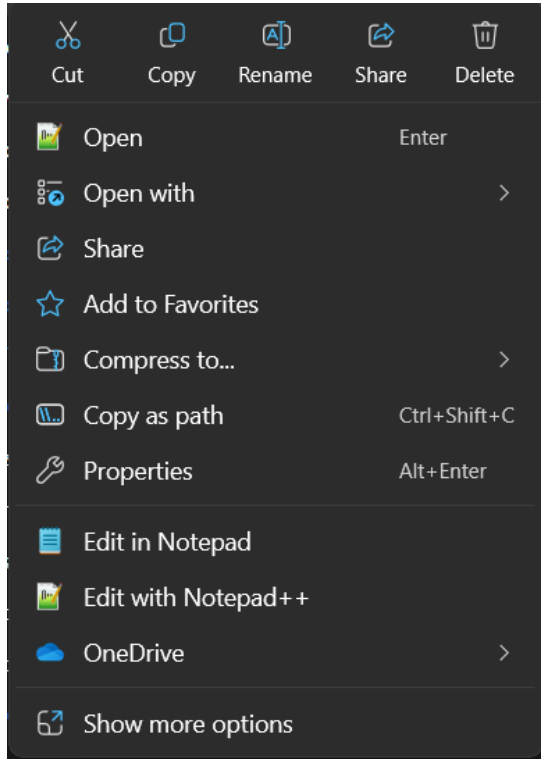
Design Implications





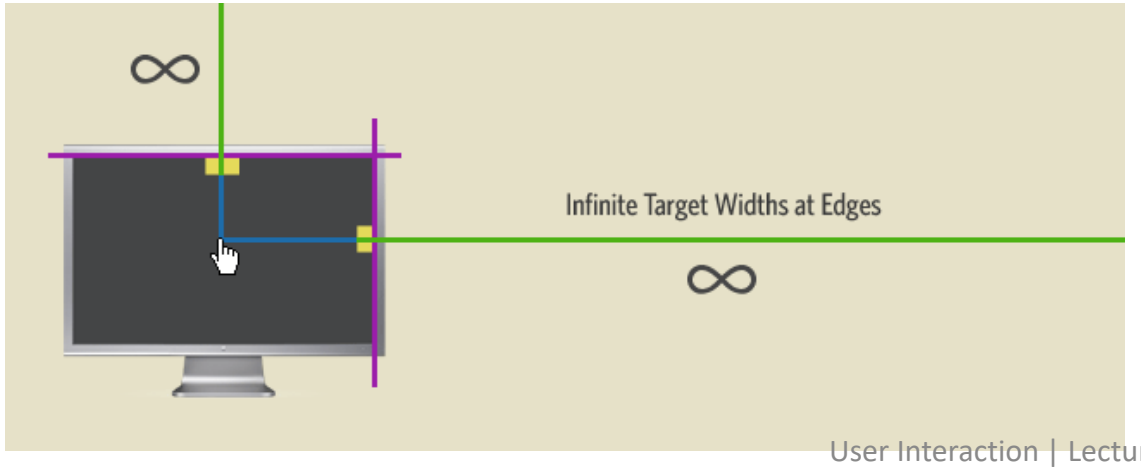
Design Implications

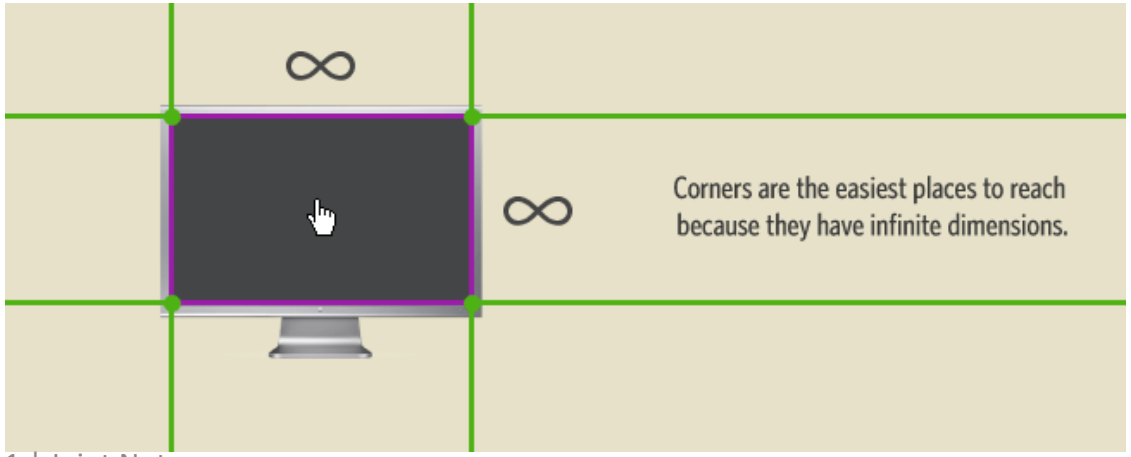




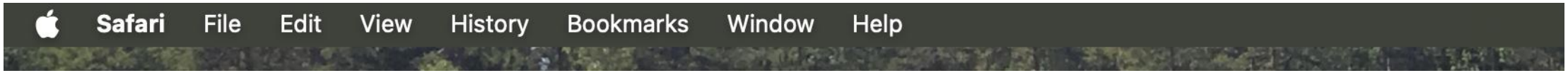
Easiest Places to Reach

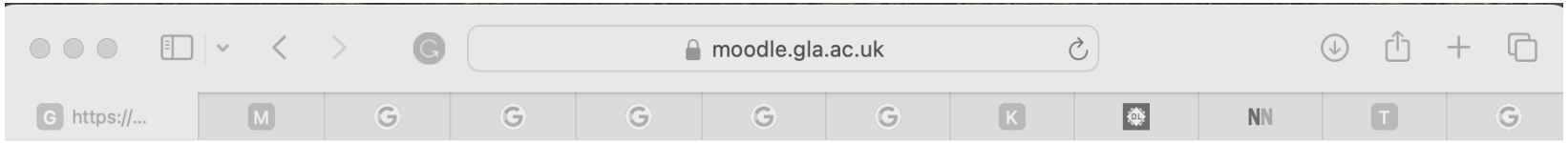
- The easiest place: where we are right now!
  - Right-click menus: pop up in place
- Screen edges – can not overshoot, so don't have to be accurate
  - Effectively, a target of infinite width in a pointer-based interface
  - Corners especially good





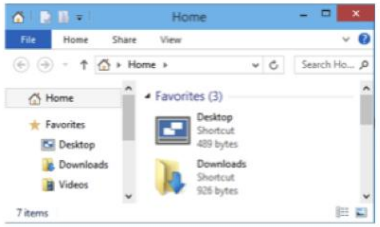
Content Bound to Edges

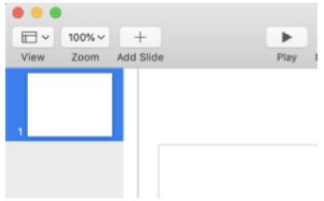


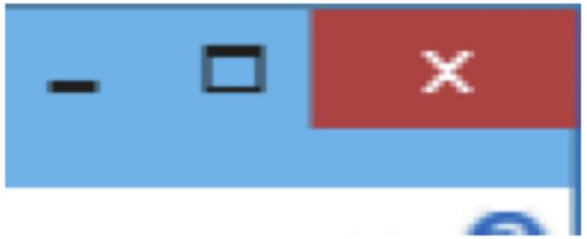


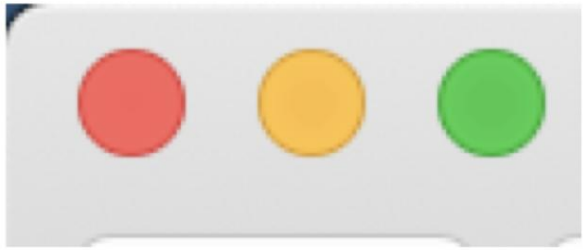
Content Bound to Corners

- Close window with ‘X’ in corner easier to reach
- Note, that colour interfaces from yesterday's theory class on design affordances







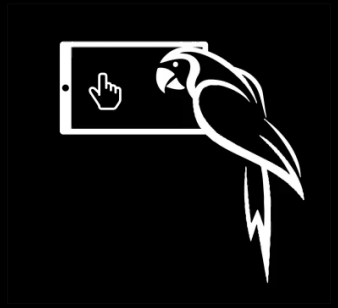


Fitts Law in Research: Parrots

INTERACT
Animal Lab

No More Angry Birds:

Investigating Touchscreen Ergonomics to Improve Tablet-based Enrichment for Parrots



Rébecca Kleinberger, Jennifer Cunha, Megan McMahon, Ilyena Hirskyj-Douglas

CHI 2024

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Interesting question: How do you test models of interaction live?

(beyond Fitts)

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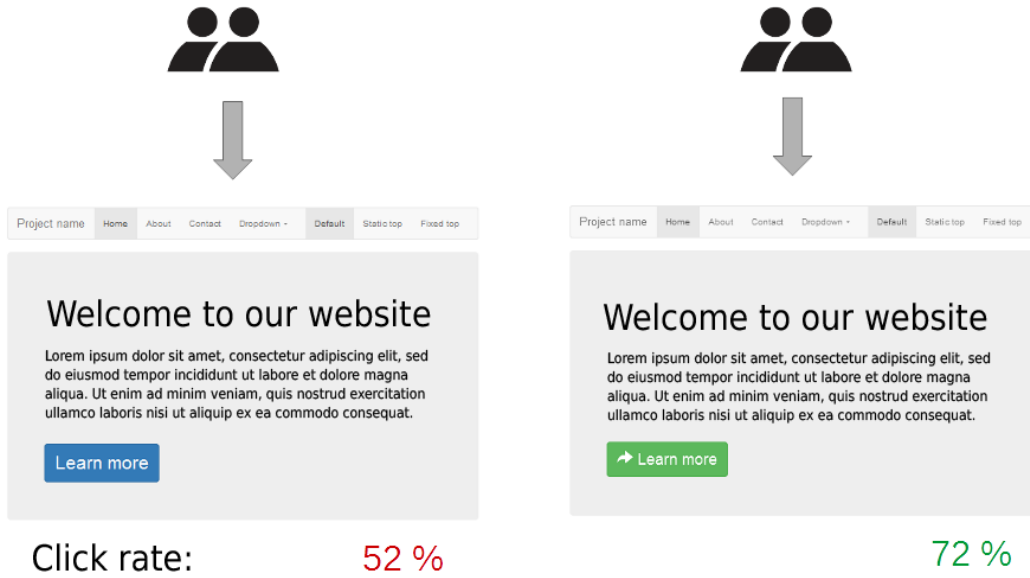
A/B testing

A/B Testing

- Many names, same idea:
  A/B testing, web experiments, control/treatment, randomised experimental design, controlled experiment, split testing...
- Randomly split traffic among different app versions
- A/Control: usually current live version – B/Treatment: new idea
- Collect metrics and analyse



A/B Testing

" However compelling the message, however great the copy, however strong the sales argument... the way a page is designed will have a dramatic impact on conversion rates, for better or for worse."
- http://www.alistapart.com/articles/designcancripple/

- Previous lectures have talked through design principles
- But still hard to accurately predict if successful!
- Often small features will have a surprisingly big effect!

Some design elements that can make a a significant difference in page performance

- Heading: Position and prominence
- Columns: Number of columns used on the page
- Visual Elements: competing for attention
- Whitespace: on a page, space to ‘breathe’
- Photos: The age, sex and appearance of someone
- Call to actions: position and colour
- Testimonials: Position
- Content type: text or as image
- …

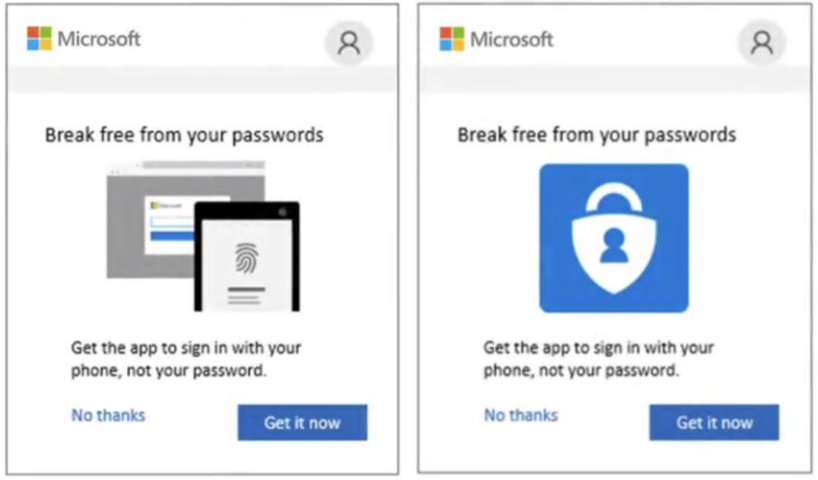
A/B at Amazon: Shopping Cart Recommendations

- Add an item to your shopping cart at a website
  → Most sites show the cart
- At Amazon, Greg Linden shows recommendations based on cart
- Evaluation
  - Pro: cross-sell more items (increase average basket size)
  - Con: distracts people from checking out (reduces conversion)
- HiPPO (Highest Paid Person's Opinion) was: stop the project!
- But: simple experiment, wildly successful, and the rest is history

For reference: R. Kohavi et al. Practical Guide to Controlled Experiments on Web. Proc. ACM KDD 2007

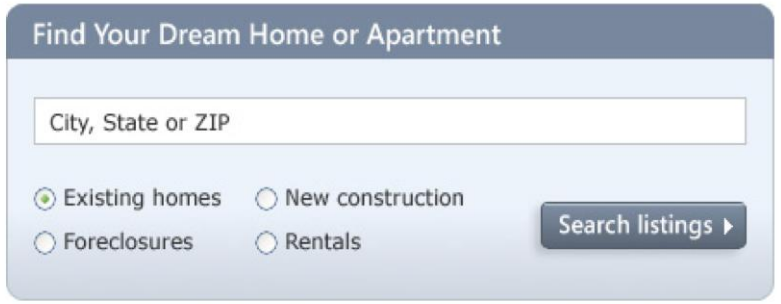
A/B at Microsoft

"We have an unprecedented opportunity to run A/B tests with online users and innovate more quickly based on actual user response. Microsoft needs to shift the culture from planning the exact features to planning a set of possible features and letting customers guide us."
– Ray Ozzie, Chief Software Architect at Microsoft



MSN Real Estate

- “Find a house” widget variations
- Overall Evaluation Criterion (OEC) : Revenue to Microsoft is generated every time a user clicks the search/find button



A

B

- A or B?

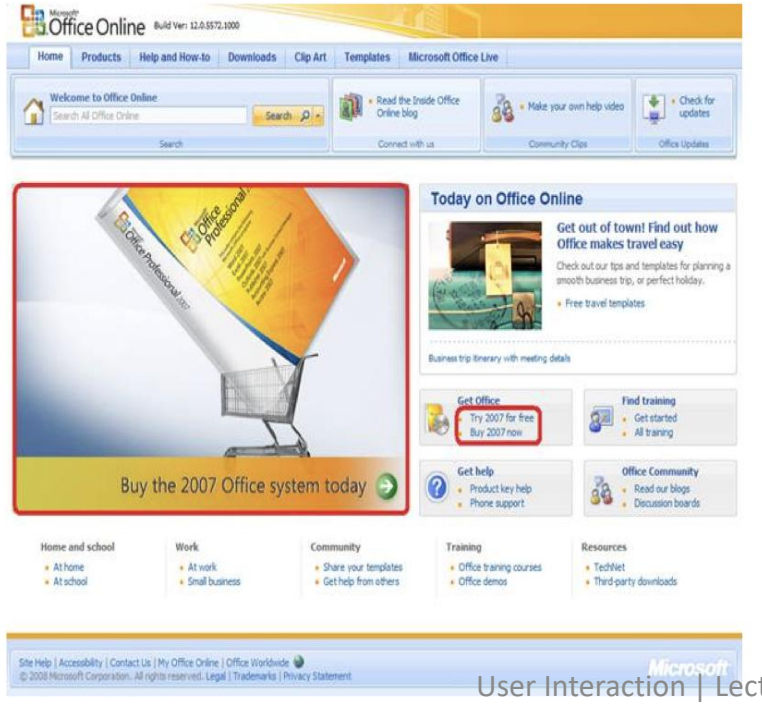
MSN Real Estate

- A was 8.5% better
- Since this is the #1 monetisation →effectively raised revenues
- The actual experiment had six variants.
  → If you're going to experiment, try more variants, especially if they're easy to implement

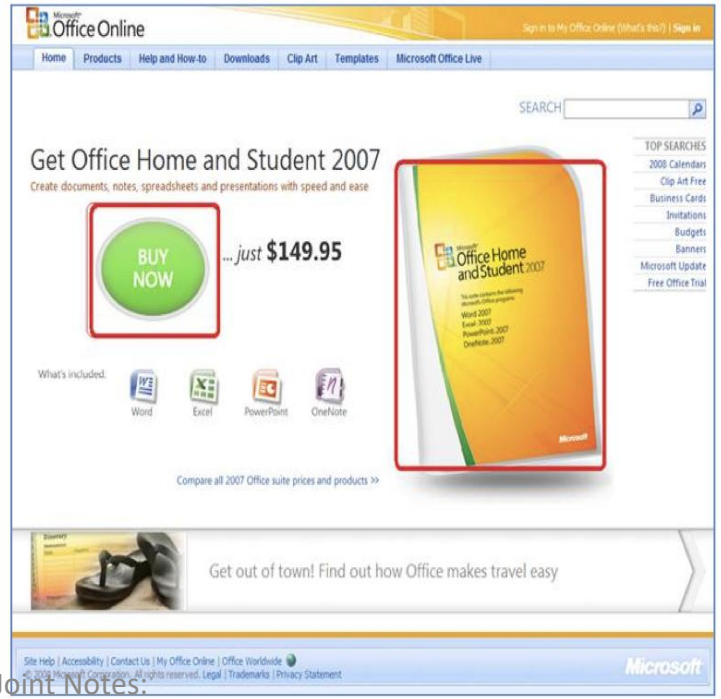
Office Online

- OEC: Clicks on revenue-generating links (red below)
- A or B?

A



B



Office Online

- B was 64% worse
- Doesn't tell us **why** one is more successful
  → Interviews, qualitative methods
- Main point: it is hard to assess the value of ideas
  → Get the data by experimenting because data beats intuition

Ramp-Up Approach

- To detect an effect, you need to expose a certain number of users to the treatment (based on power calculations)
- Fastest way to achieve that exposure → equal-probability variants – e.g., 50/50% for A/B
- But: don't start an experiment at 50/50%
  - That's too much risk → Ramp up over a short period
  - Start an experiment at 0.1% of user base (or other small value)
  - Do simple analyses to make sure no egregious problems can be detected
  - Ramp up to a more significant percentage, and repeat until 50%

Advantages of A/B testing

- It tests for causal relationships, not just correlations
  → measure direct impact of change
- It reduces the effect of external factors
  → e.g., history/seasonality impact A and B the same
- Overcome poor intuition, especially with novel ideas
  - All too often, the less data, the stronger the opinions
  - So, get the data through experimentation

Challenges with A/B testing

- Organisation has to agree on OEC (Overall Evaluation Criterion)
  - This is hard, but it provides a clear direction and project alignment
- Quantitative metrics may not explain **why** one is better or worse
  - No help for designers solve
  - No guidance for next design iteration

Challenges with A/B testing

- Primacy effect
  - cognitive bias where users tend to favor or remember the first piece of information, they encounter more than subsequent information
  - Changing the app or site may degrade the user experience (temporarily) even if the new design is better
- Multiple experiments
  - Statistical variance increases → harder to get statistically significant results
- Consistency and contamination
  - Assignment to A or B is usually cookie-based, but people may use multiple machines or erase cookies
- Be careful to do proper randomisation!

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Questions?
Comments?
Concerns?

Fitts Task (30 mins)

- Open http://www.cs.cmu.edu/~bam/uicourse/2014inter/fittslaw/
- In your group, use the online Fitts law program for at least two pointing devices of your choice (e.g. large vs. small mouse, mouse vs. trackball, touchpad vs. TrackPoint, mice with very different shapes).
- Feel free to insert your favourite mouse (pointing device) here,
  - be sure to work with your group and collaborate to evaluate one device multiple times
  - More than one person must do this task - the more data, the better!
  - Write down results (device, total time, and error rate).
- From this data, ask the following:
  - Which device performed the best? (lowest meantime)
  - Which pointing device did not work so well? (high error rates)
  - Theories as to why you think one device worked better than the other.

→ Write the answer to these questions in your Teams space.

Fitts Task: Class Discussion

User Interaction Topics

- ✅ HCI History and Introduction
- ✅ Usability and Heuristics
- ✅ Heuristic Evaluation and Human Cognition
- ✅ Human Perception and Capabilities
- ✅ Experimental Design & Variables Research
- ✅ Personas and Scenarios
- ✅ Surveys in HCI
- ✅ Ethnography
- ✅ Statistical Methods
- ✅ Theories in HCI & User-Centered Design
- ✅ Models of Interaction
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Reading

"Modeling Interaction", Human-Computer Interaction, 2013, Elsevier, Section 7- 7.2.1