

Interaction Design

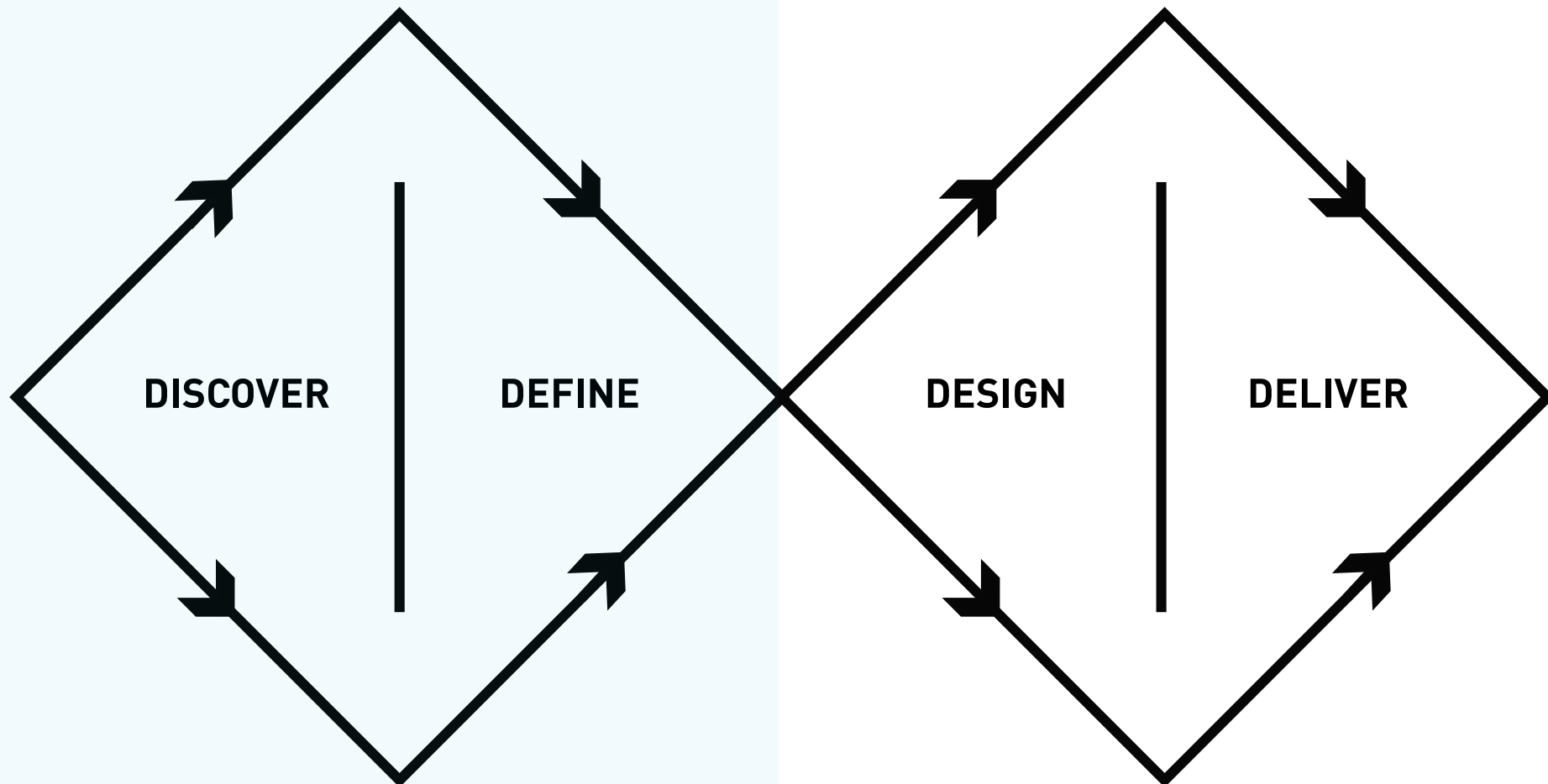
Chapter 6 (June 8th, 2017, 9am-12pm):
Laws of Interaction Design

Why laws? What for?

- We will learn laws about:
 - **computers**
 - **human motor skills**
 - **human cognition**
- There are 3 good reasons for laws in ID:
 - **describe**: understand what is going on
 - **predict** what will happen if...
 - **generate** new alternatives

Double Diamond

- describe
- predict
- generate



Why? and How?

source: [2]

Laws of Interaction Design

- Moore's law
- Buxton's law
- Fitts' law
- Steering law
- Guiard's Kinematic chain model
- Hick's law
- Law of practice
- Murphy's law

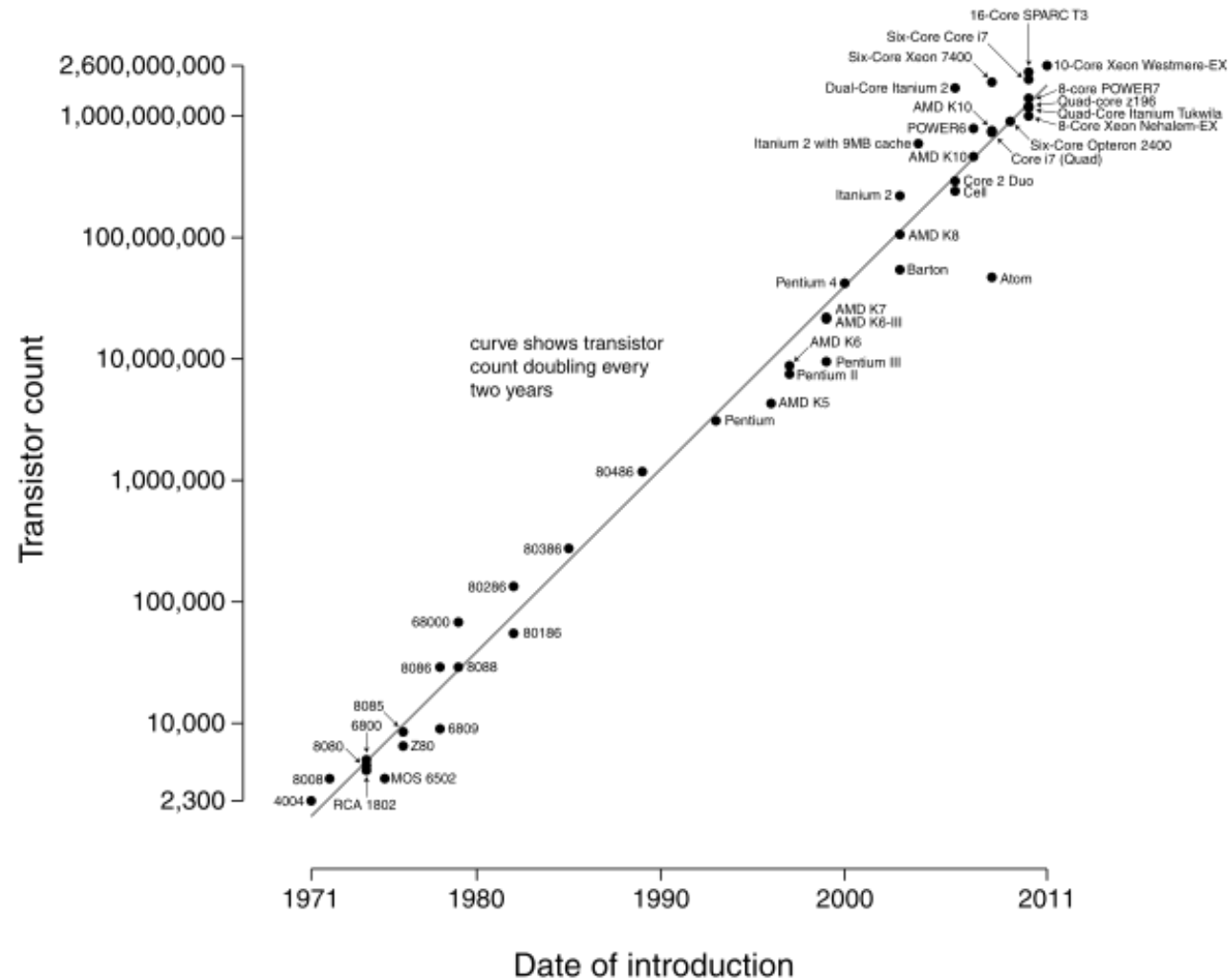
Moore's law

*“The complexity for minimum component costs has increased at a rate of roughly a **factor of two per year**... Certainly over the short term this rate can be expected to continue, if not to increase. Over the longer term, the rate of increase is a bit more uncertain, although there is no reason to believe it will not remain nearly constant for at least 10 years. That means by 1975, the number of components per integrated circuit for minimum cost will be 65,000. I believe that such a large circuit can be built on a single wafer.”*

[Moore, Gordon E. "Cramming more components onto integrated circuits". Electronics, Volume 38, Number 8, April 19, 1965.]

Moore's law illustration

Microprocessor Transistor Counts 1971-2011 & Moore's Law



Moore's law implications

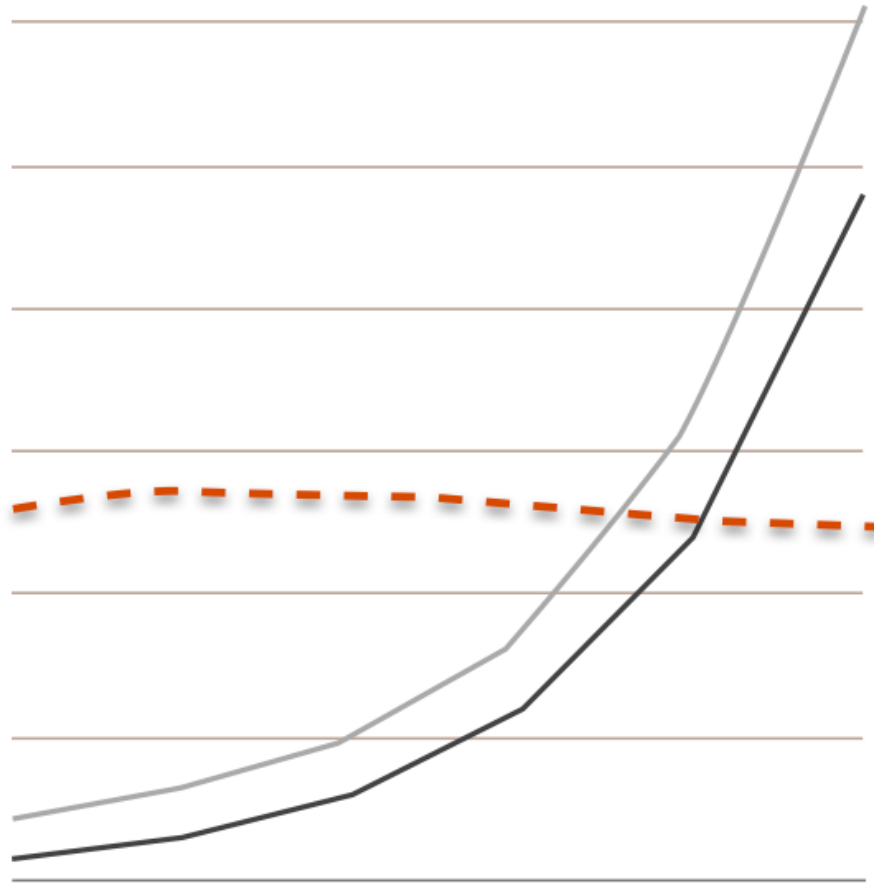
Don't worry too much about:

- computing power
- storage capacity
- screen resolution
- device size
- weight
- battery life (?)

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Buxton's law



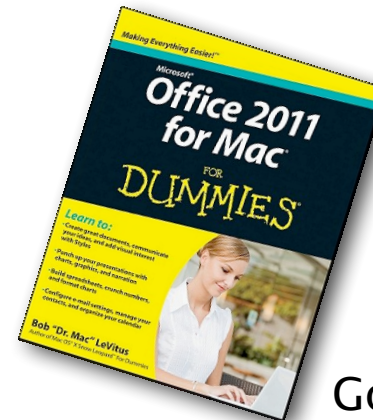
Moore's law



With iOS 5, we've added over 200 new features — taking a mobile operating system that was already years ahead of anything else and moving it even further ahead.

[Learn more](#)

Buxton's law



God's law

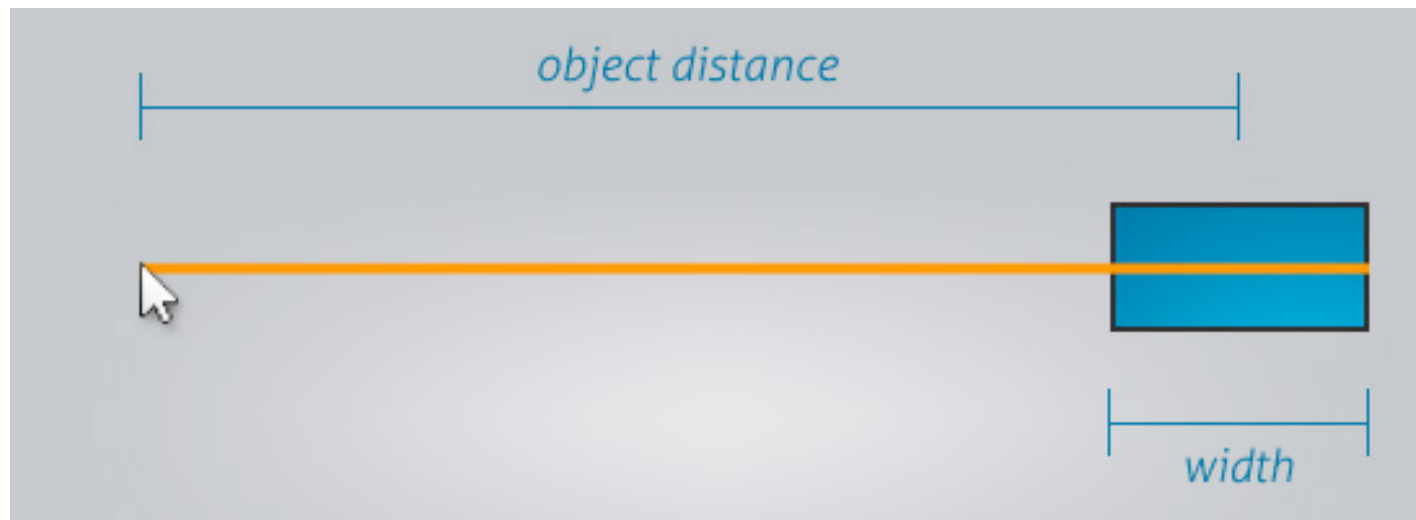
<http://www.billbuxton.com/LessIsMore.pdf>

Laws of Interaction Design

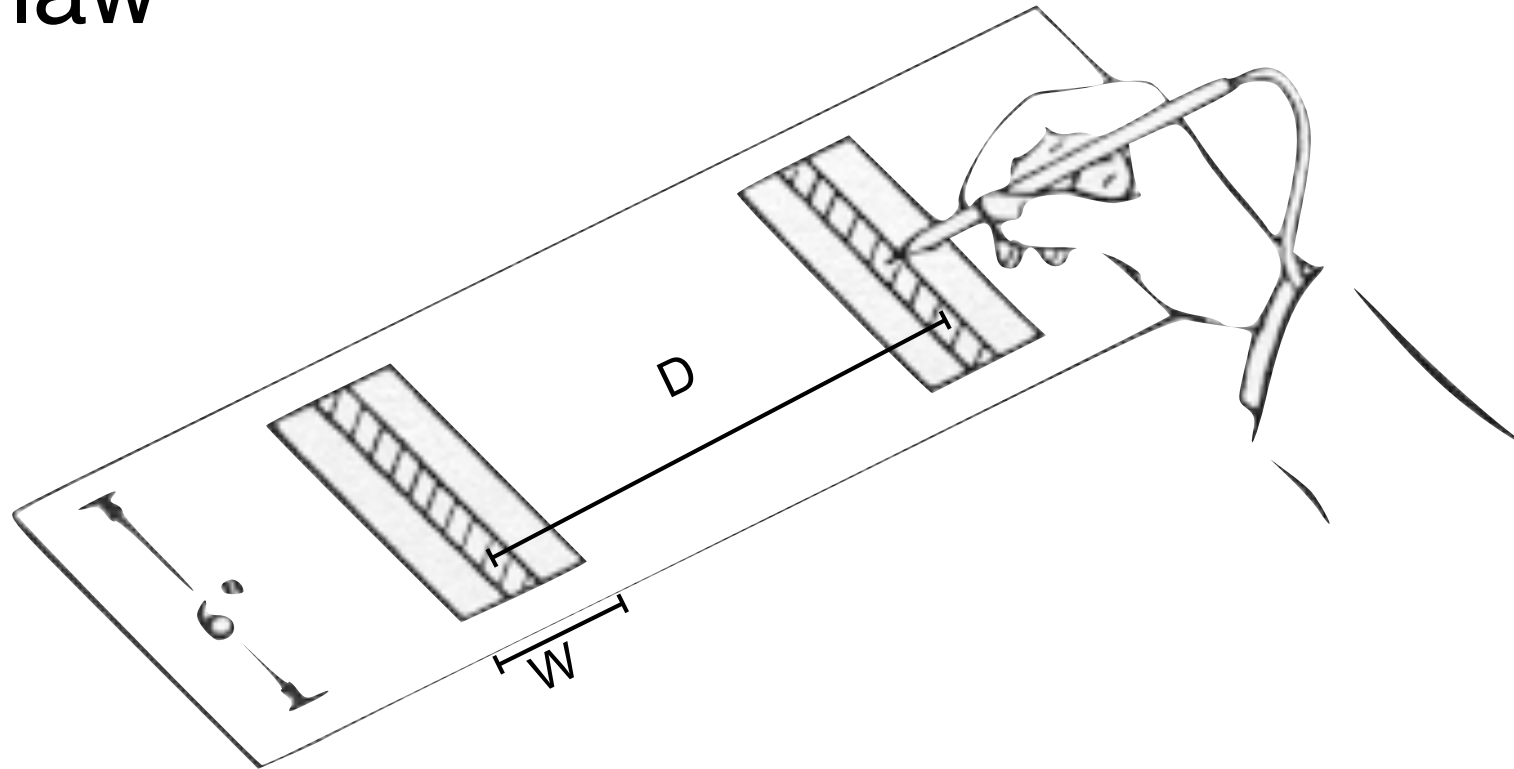
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Fitts' law

The time to acquire a target is a function of the distance to and width of the target.



Fitts' law



$$MT = a + b * ID = a + b * \log_2 \left(\frac{D}{W} + 1 \right)$$

Distance
↓
↑
Width

↑
Coefficients
a: Intercept
b: Slope

↑
Movement Time

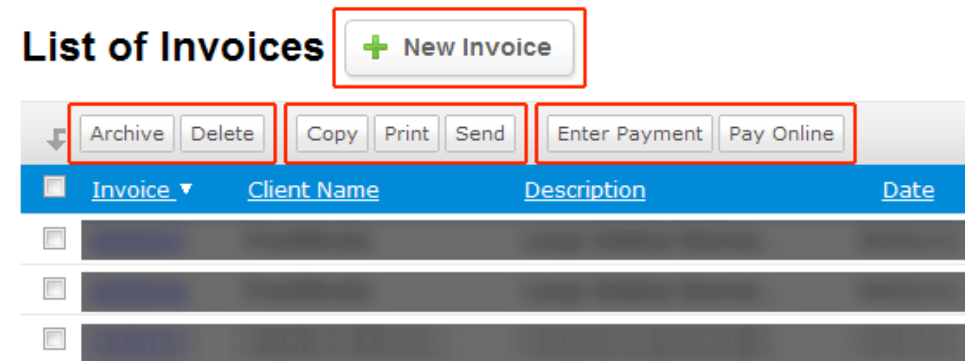
Speed-accuracy tradeoff:



<http://www.youtube.com/watch?v=kly2QA1bFc8>

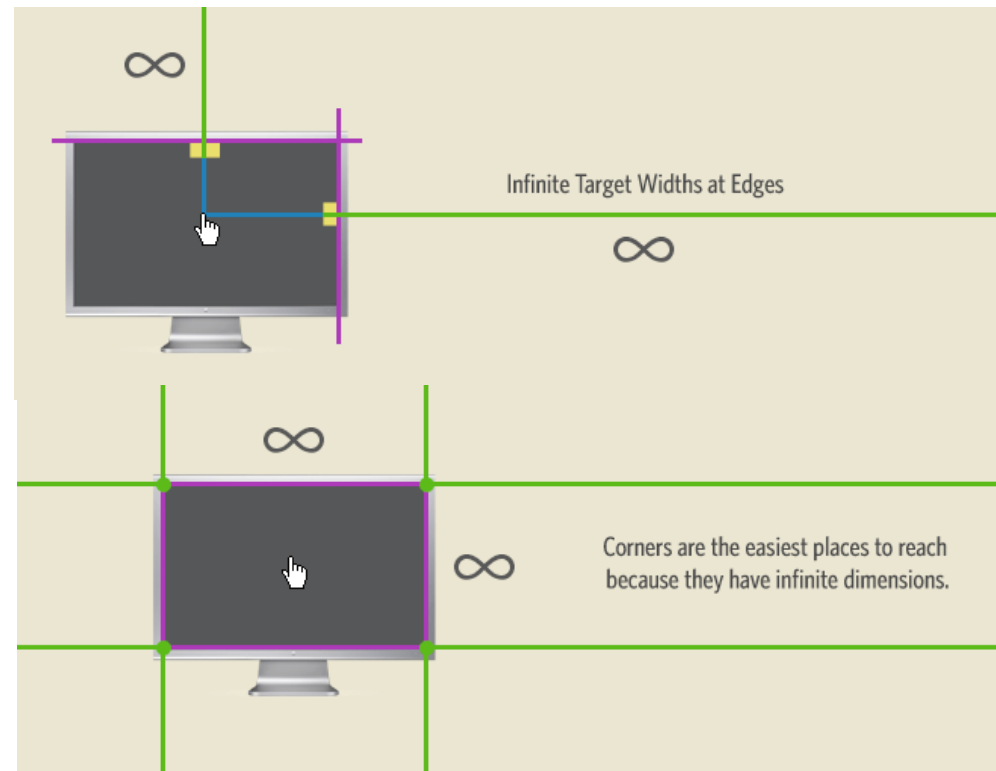
Implications of Fitts' law

Larger targets are easier to hit
 -> maximize button size



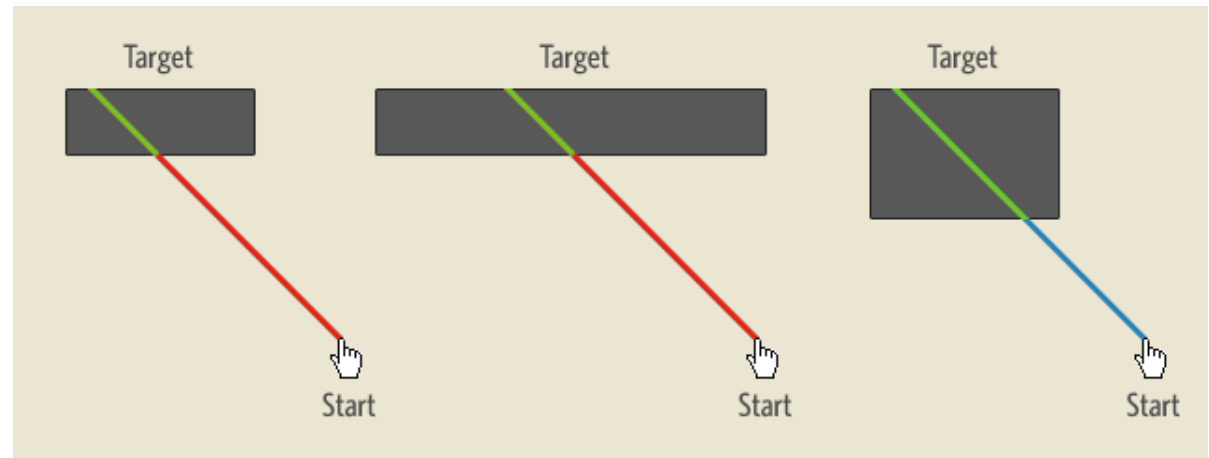
Movement time increases
 (logarithmically) with distance
 -> minimize distances
 -> no movement is even better!

Infinite targets:
 -> leverage screen borders
 -> leverage corners

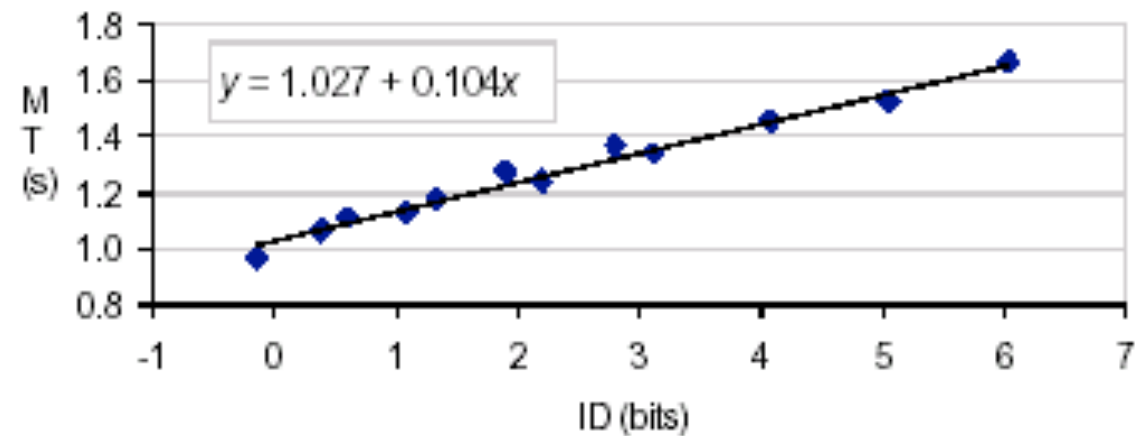


Bigger Is Not Always Better

Movement direction to target



Logarithmic improvements
with size



Mackenzie's reevaluation of Card's Fitts' Experiment for text selection

Stu Card

A Supporting Science

Interview March 2002

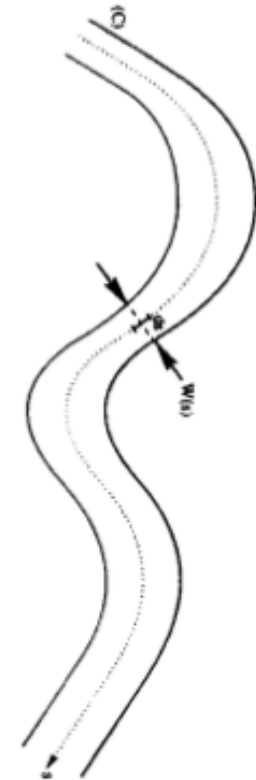
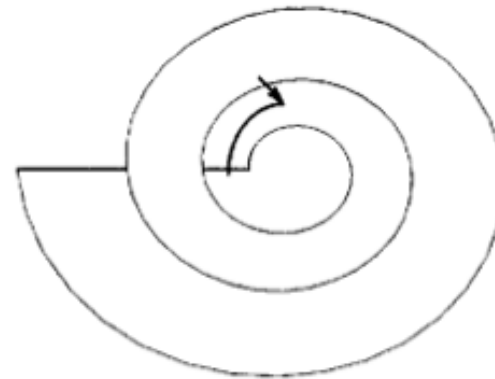
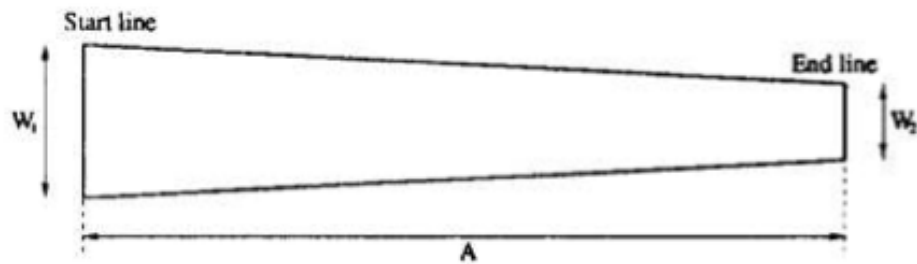


Laws of Interaction Design

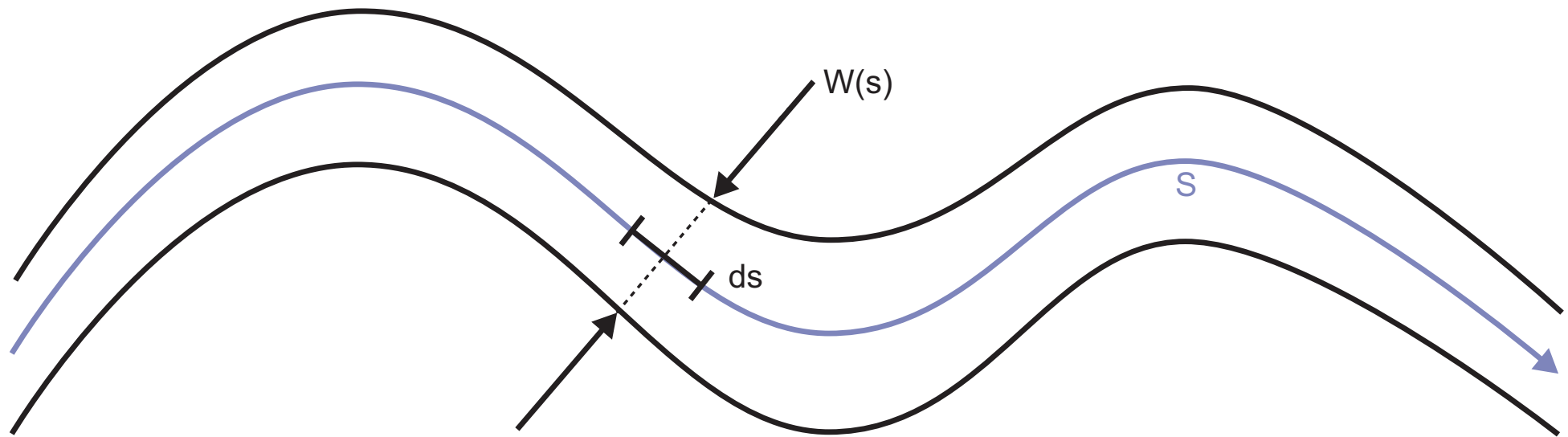
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Why is it called Steering Law??

- Early work focused on car driving scenarios and models with straight tunnels
- Various example tunnel shapes have been explored



Steering law on curved paths



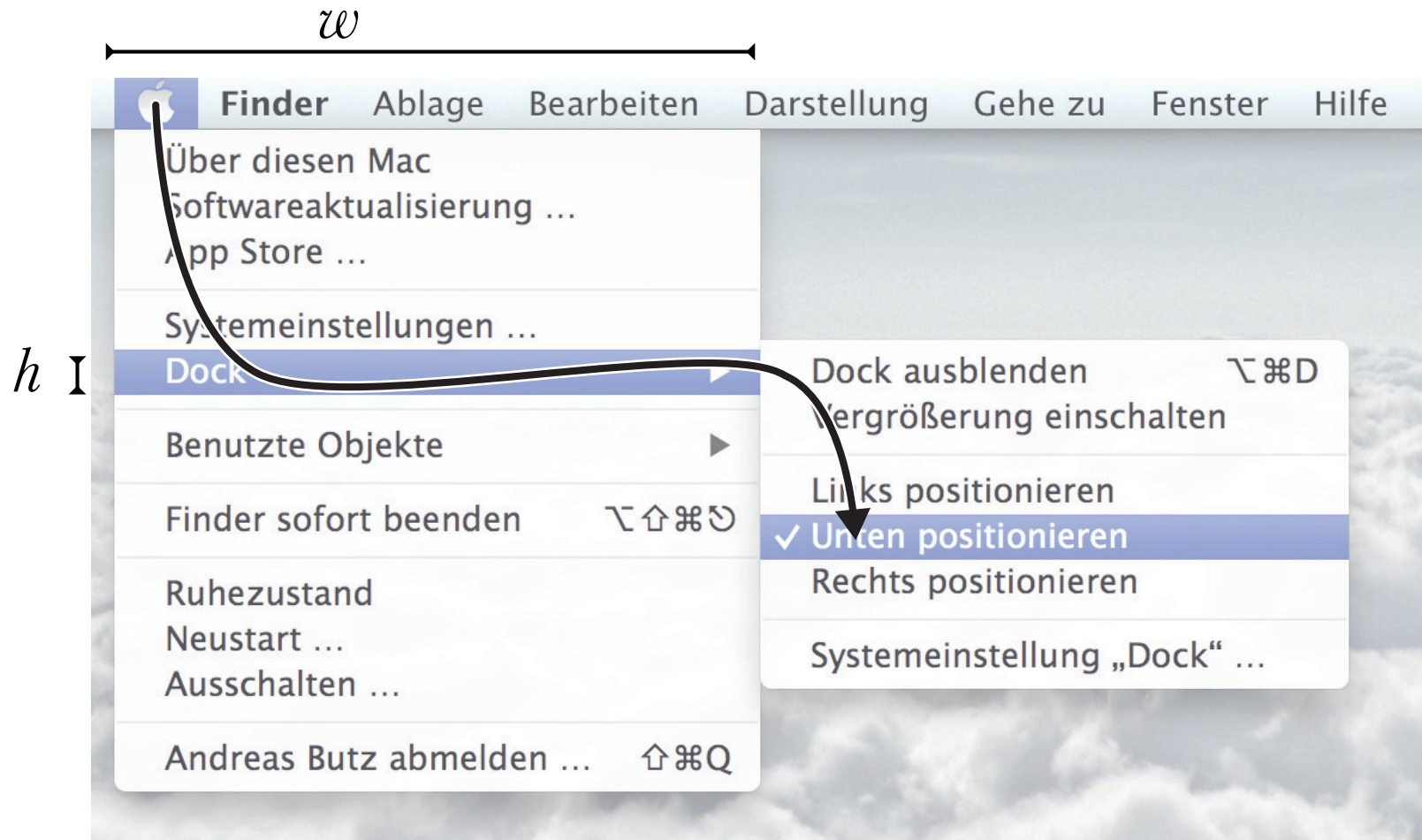
average time to navigate through the path

$$T = a + b * \int_S \frac{1}{W(s)} ds$$

experimentally fitted constants

width of the path at s

Example application of the steering law



$$T = \boxed{a_1 + b_1 * \log_2\left(\frac{nh}{h} + 1\right)} + \boxed{a_2 + b_2 * \frac{w}{h}} + \dots$$

vertical: Fitts' law horizontal: steering law

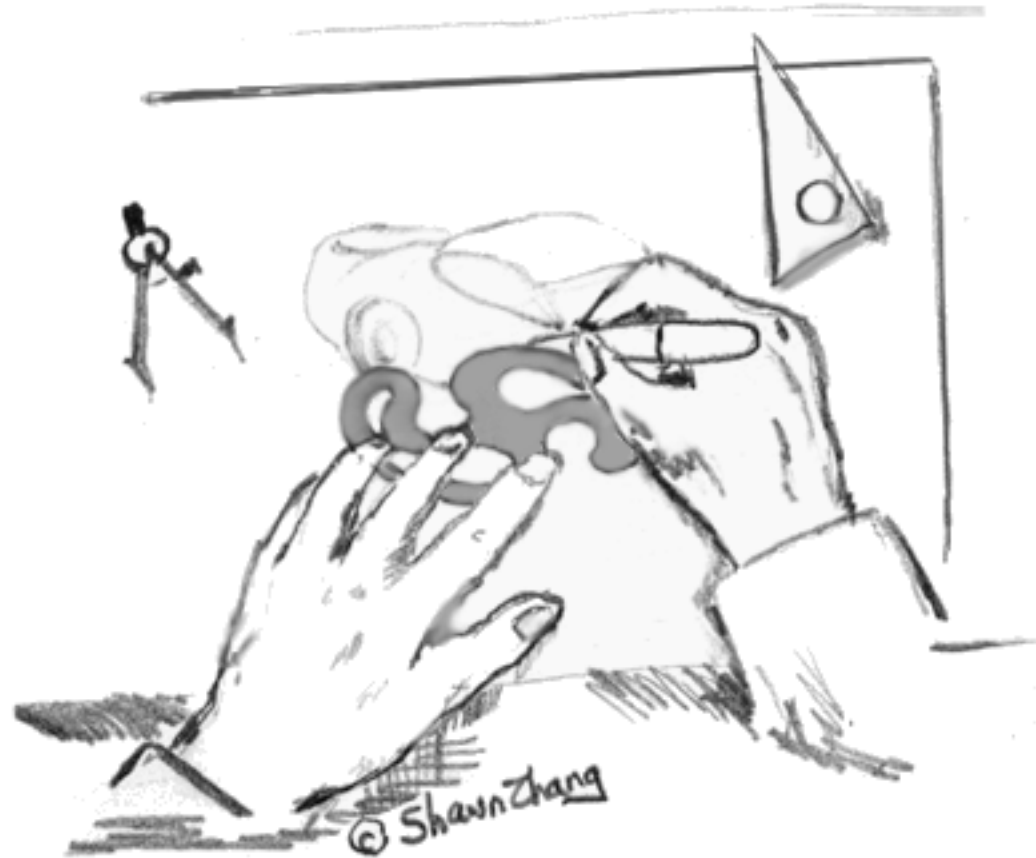
Mini-discussion

How can we use fitts' law and steering law to make a computer game more challenging?

Laws of Interaction Design

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- **Guiard's Kinematic chain**
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A human capability



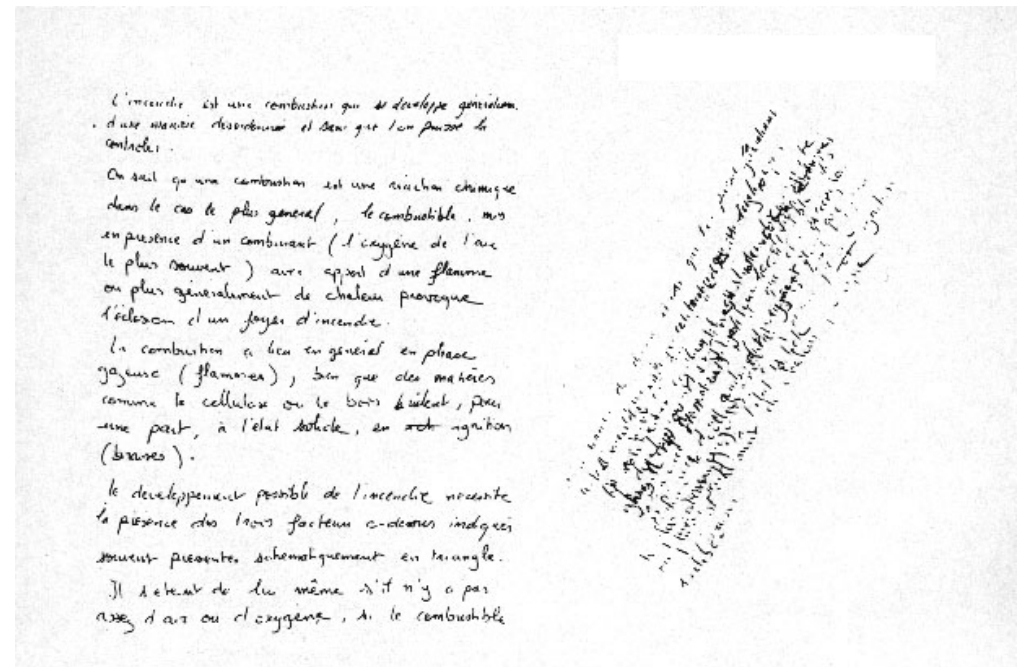
From The Two-Handed Desktop Interface: Are We There Yet? [MacKenzie & Guiard, 2001]

Guiard's Kinematic Chain

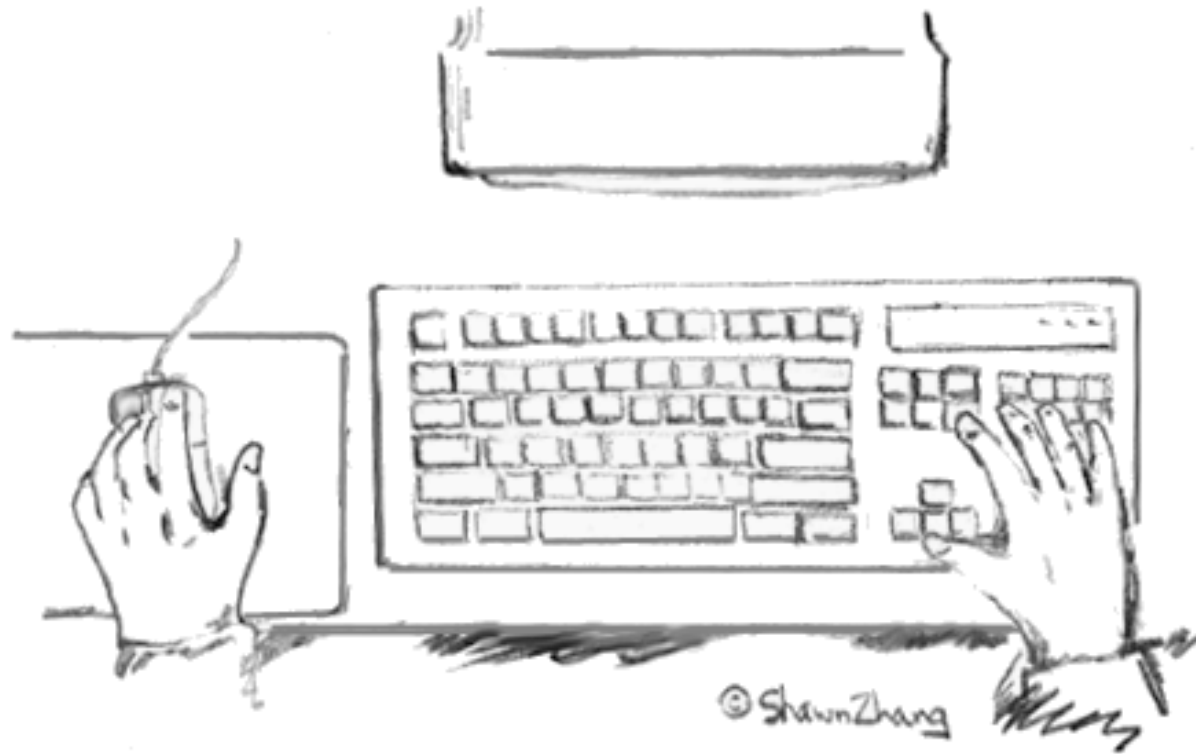
*“Under standard conditions, the spontaneous writing speed of adults is **reduced** by some **20%** when instructions **prevent the non-preferred hand** from manipulating the page”*

Non-dominant hand provides a frame of reference for the dominant hand

- ▶ Non-dominant hand operates at a coarse temporal and spatial scale;
- ▶ Dominant hand operates at a fine temporal and spatial scale



Two handed-interaction at the desktop



From The Two-Handed Desktop Interface: Are We There Yet? [MacKenzie & Guiard, 2001]

Mini-brainstorming

Which tasks in daily life follow a similar distribution of roles between the hands?

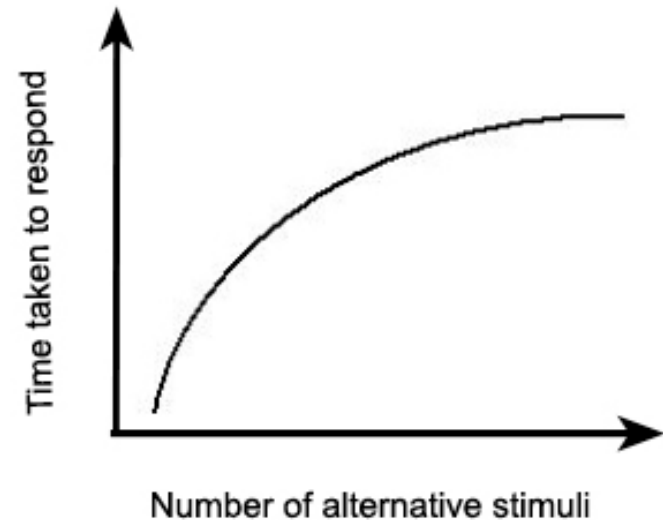
Which ones don't ???

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Hick's law

*Given n known and **equally probable** choices, the average reaction **time** T required to **choose among them** is:*



$$\text{Time} \longrightarrow T = b \cdot \log_2 (n + 1)$$

Annotations for the equation:

- An arrow points from 'Time' to T .
- An arrow points from 'Coefficient' to b .
- An arrow points from 'Choices' to n .
- An arrow points from 'binary search strategy' to \log_2 .

Hick's Law Examples (really? let's discuss!)

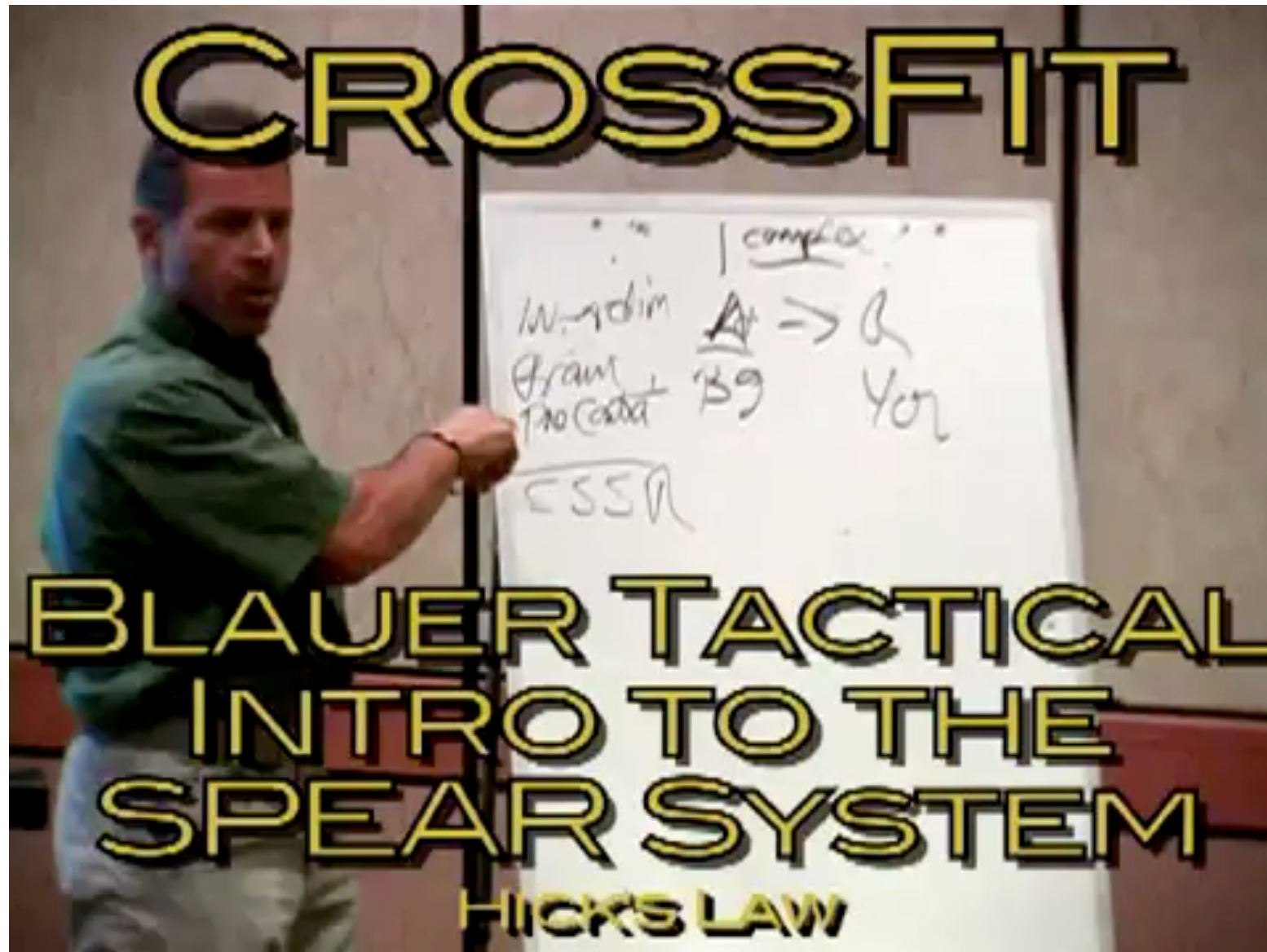


<http://www.hier-luebeck.de/wp-content/uploads/2010/09/StartMenuWindows7.jpg>



http://www.photosopic.com/iphone_screen

In another context, and slightly wrong ;-)...



<https://www.youtube.com/watch?v=w0hJveJ8Hp0>

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The Power Law of Practice

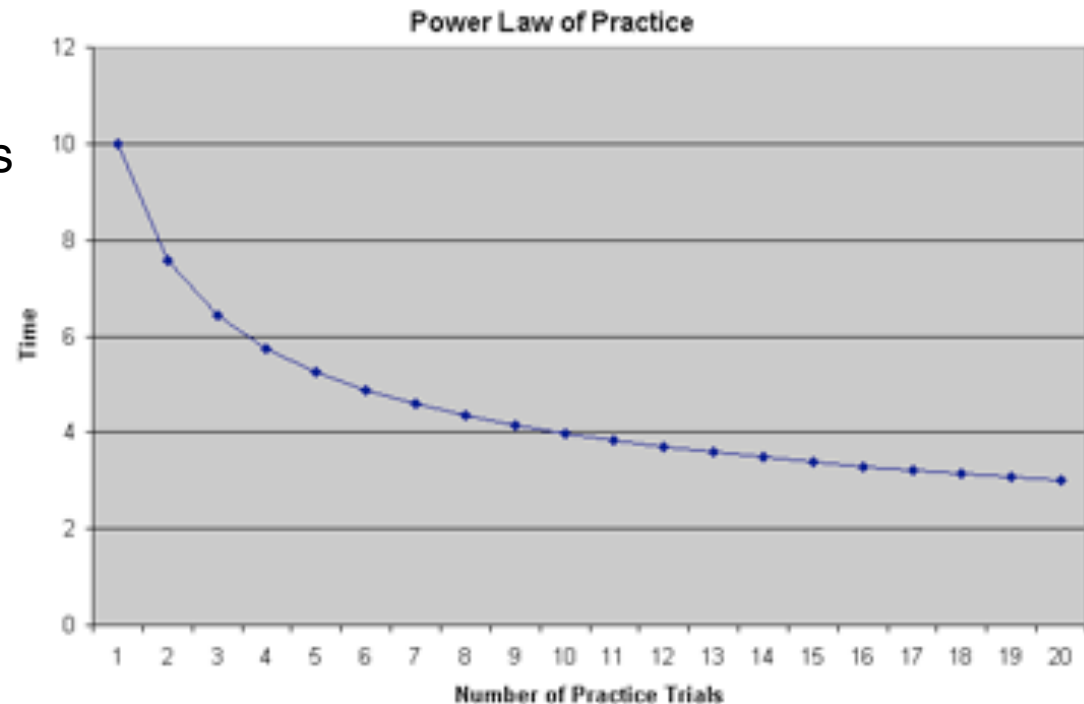
- ▶ When performing a task based on practice trials, people improve in speed at a decaying exponential rate.
- ▶ The time needed for a particular task decreases in proportion to the number of practice trials taken raised to a power of about $a = -0.4$
- ▶ The logarithm of the time needed for a particular task decreases linearly with the logarithm of the number of practice trials taken (this formulation is for the math geeks... ;-)

Completion time
for trial n

$$T(n) = T(1) n^a + c$$

Completion time
for trial 1

Constants



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Murphy's law

“Whatever can go wrong, will go wrong.”

[Edward Aloysius Murphy Jr., 1949]

“If there's more than one possible outcome of a job or task, and one of those outcomes will result in disaster or an undesirable consequence, then somebody will do it that way.”

Implications of Murphy's law

- ▶ Prepare for human errors, wrong input etc.
 - do sanity checks in dialogs
 - provide useful defaults
 - make serious mistakes hard

- ▶ When building stuff, provide extra time for:
 - mistakes in manufacturing
 - non-functioning tools
 - faulty material
 - misunderstandings

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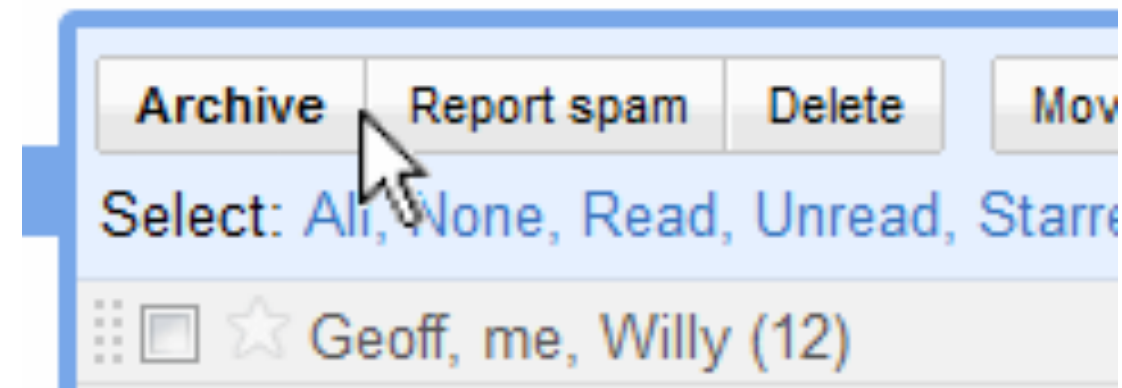
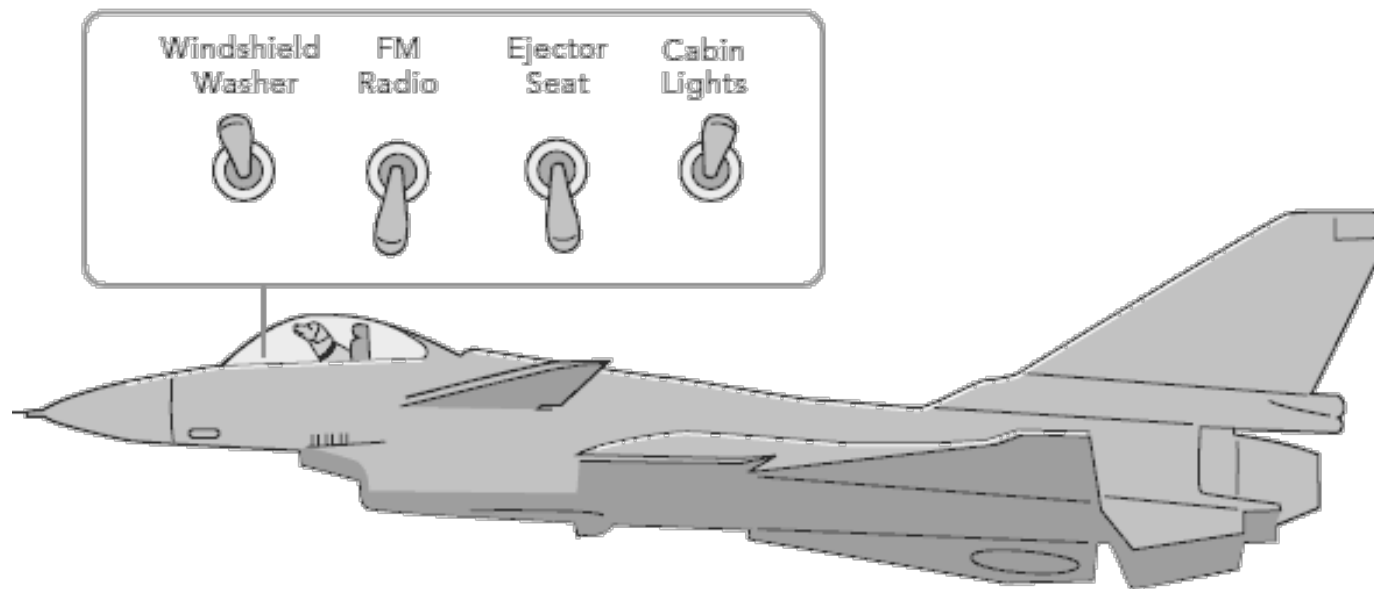
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Murphy's vs. Fitts' law



Murphy's law is still reality!



<http://www.bergsteigen.com/news/toedlicher-unfall-wegen-falsch-montierter-express>

What have we learned today?

about computers:

Moore's law

Buxton's law

about human motor skills:

Fitts' law

Steering law

Guiard's Kinematic chain model

about human cognition:

Hick's law

Law of practice

Murphy's law