Interaction Design

Chapter 6 (June 13, 2019, 9am-12pm):
Laws of Interaction Design

Why laws? What for?

- We will learn laws about:

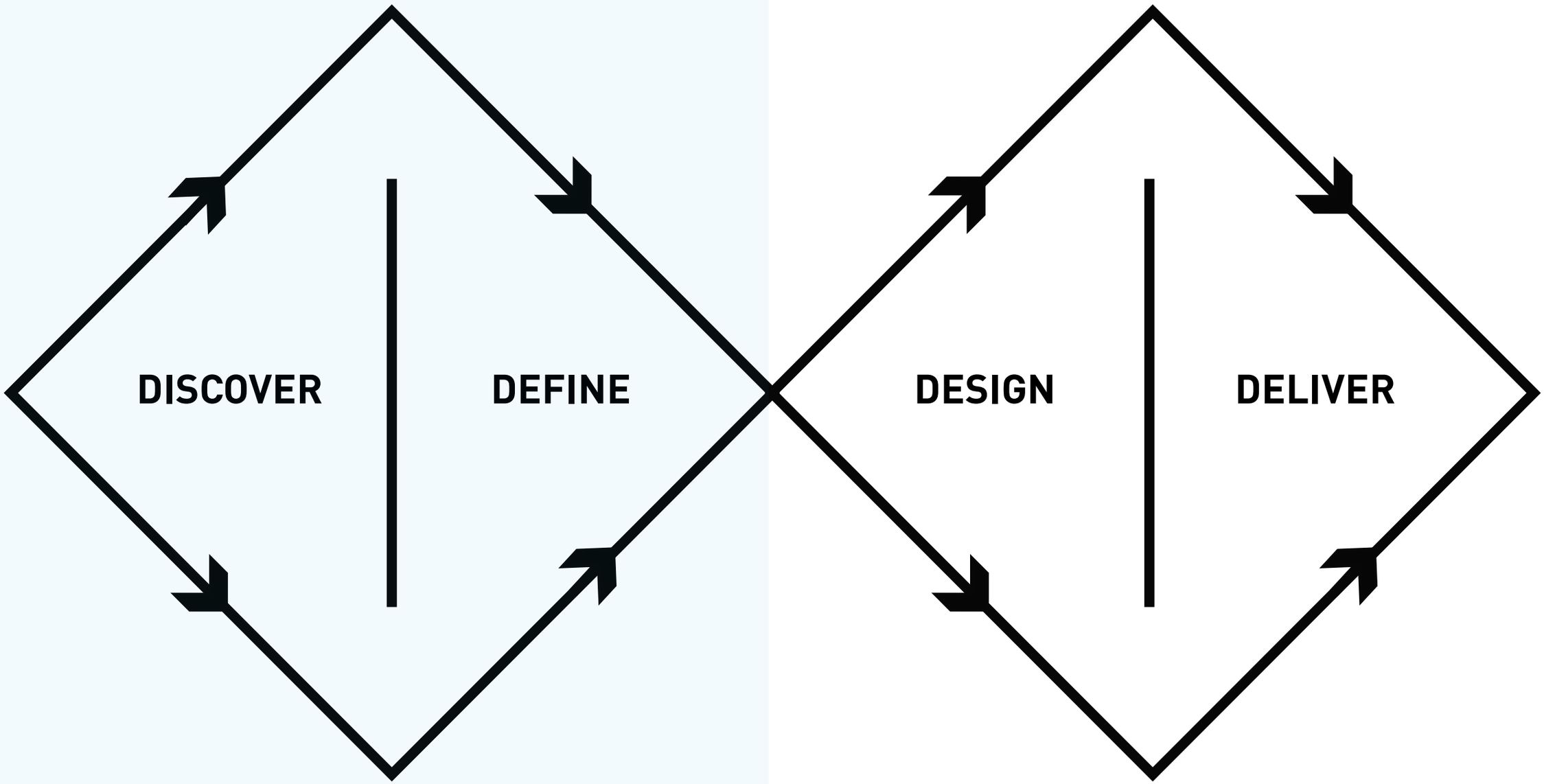
- **computers**
- **human motor skills**
- **human cognition**

- 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

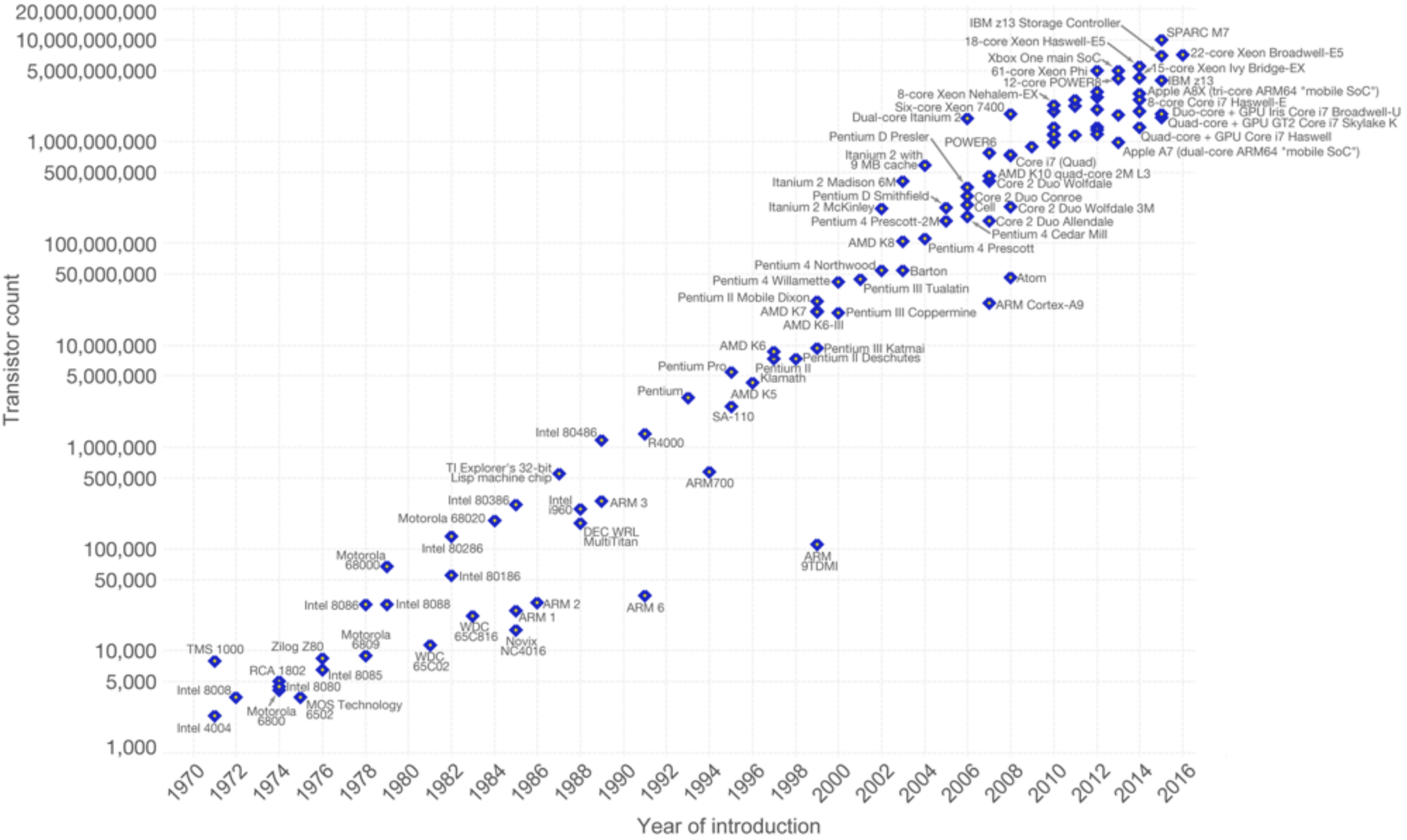
Moore’s law

“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**.]

Source: https://en.wikipedia.org/wiki/Moore%27s_law#/media/File:Moore%27s_Law_Transistor_Count_1971-2016.png

Moore’s law illustration



see: https://www.welt.de/wirtschaft/webwelt/article152297214/Das-fundamentale-Computer-Gesetz-gilt-nicht-mehr.html

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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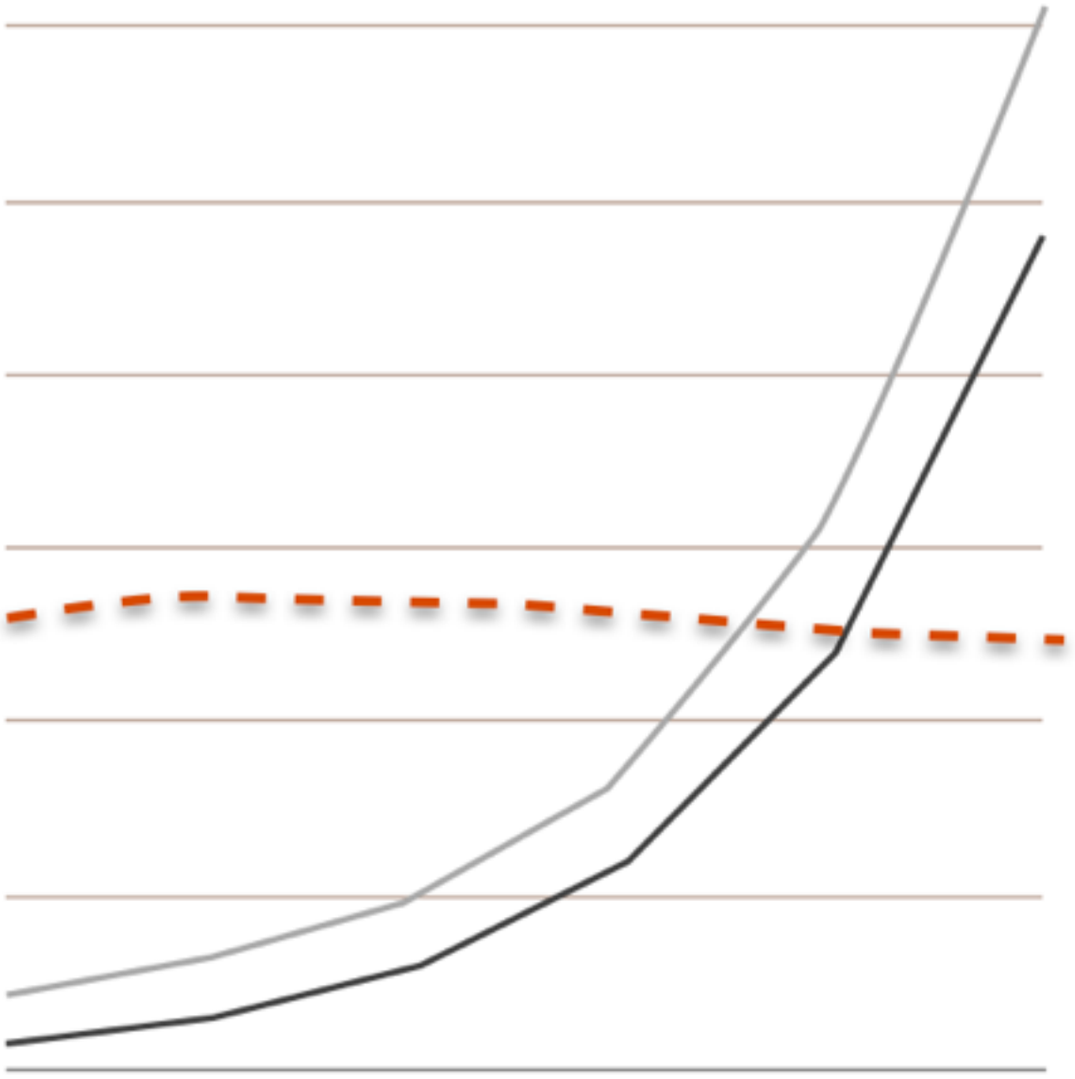
Buxton’s law



Moore’s law

Buxton’s law

God’s law

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

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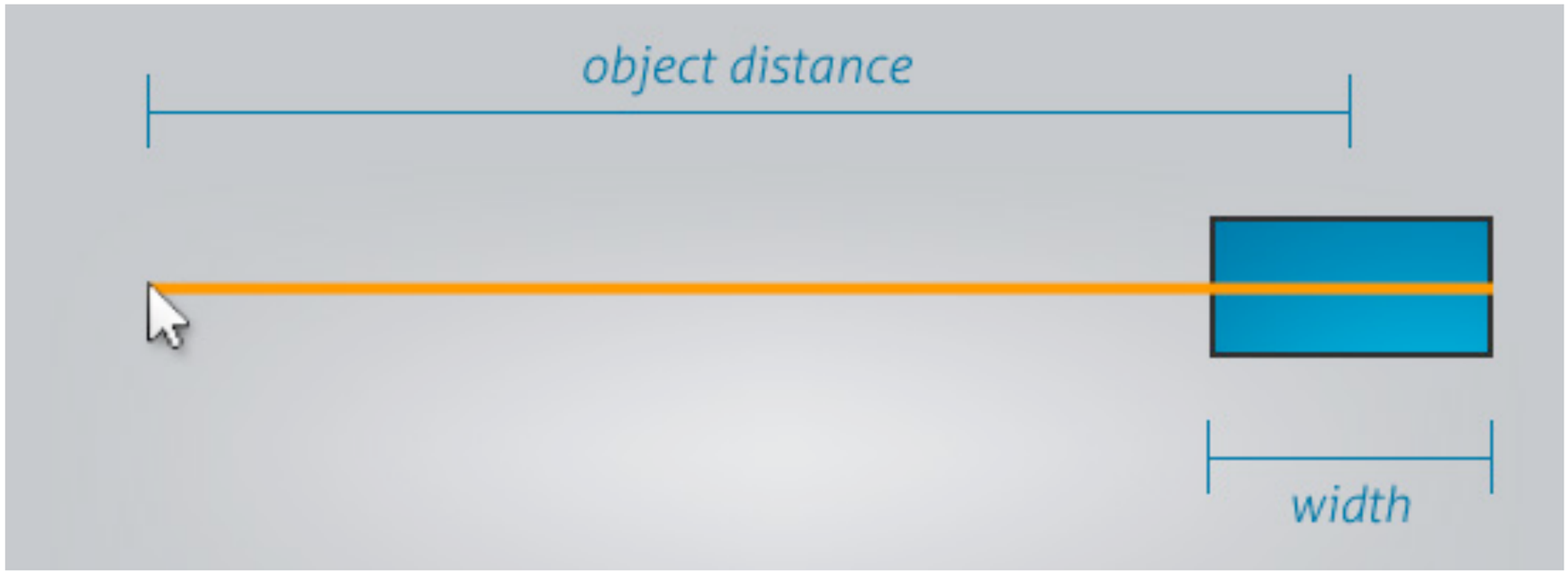
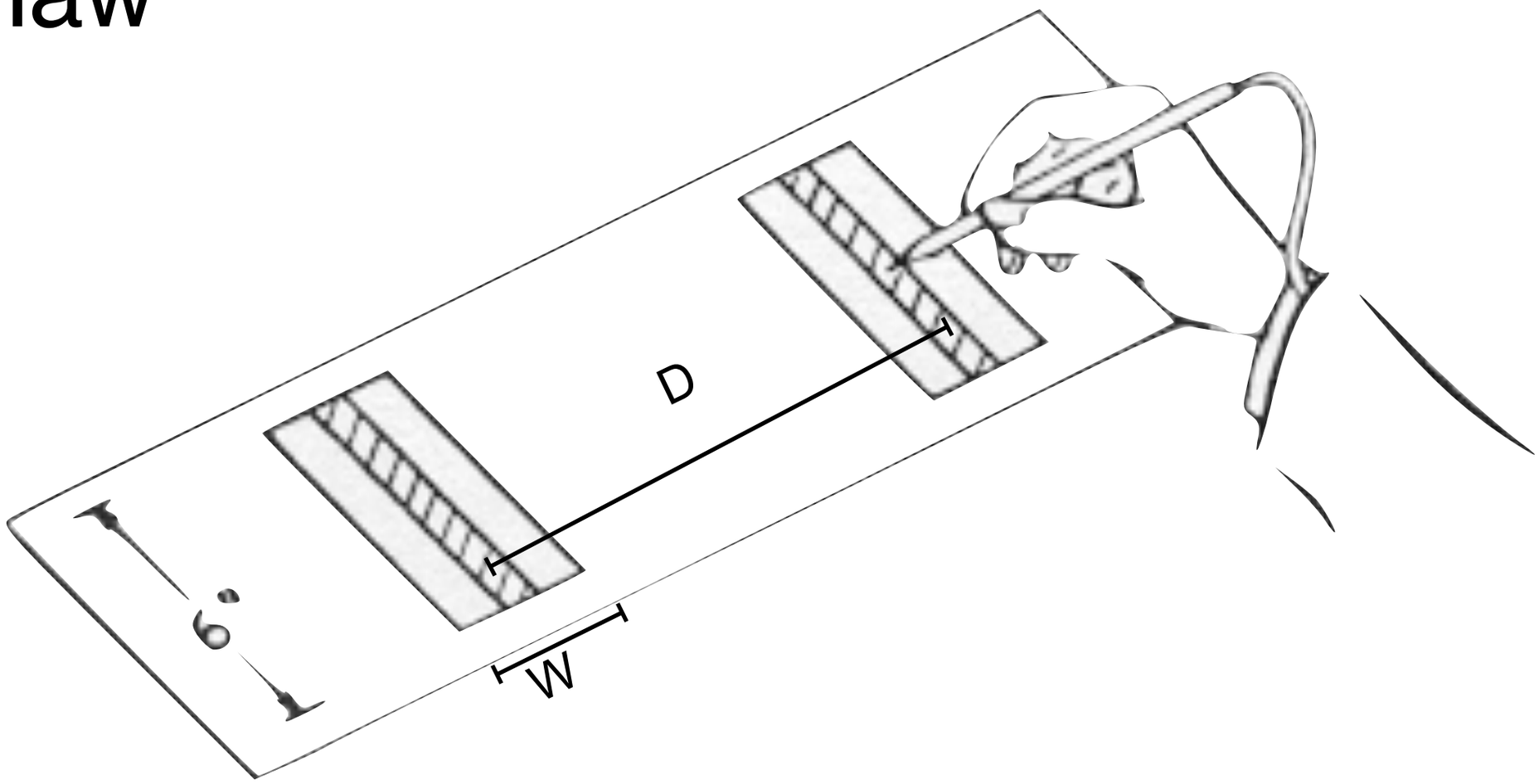
Illustration from http://sixrevisions.com/usabilityaccessibility/improving-usability-with-fitts-law/

Fitts' law

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



Fitts' law



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

Distance

Width

Movement Time

Coefficients
a: Intercept
b: Slope

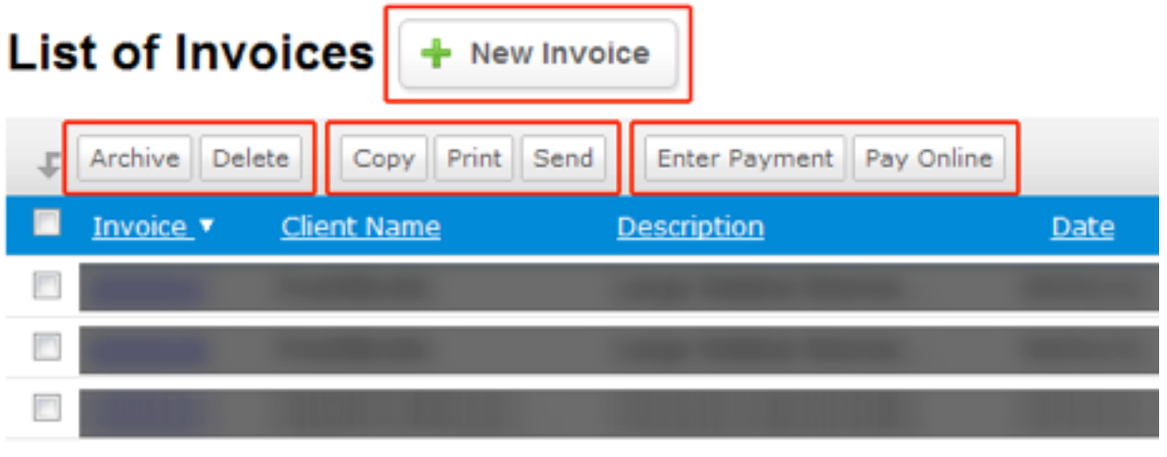
Speed-accuracy tradeoff:

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

Illustration from http://particletree.com/features/visualizing-fittss-law/

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

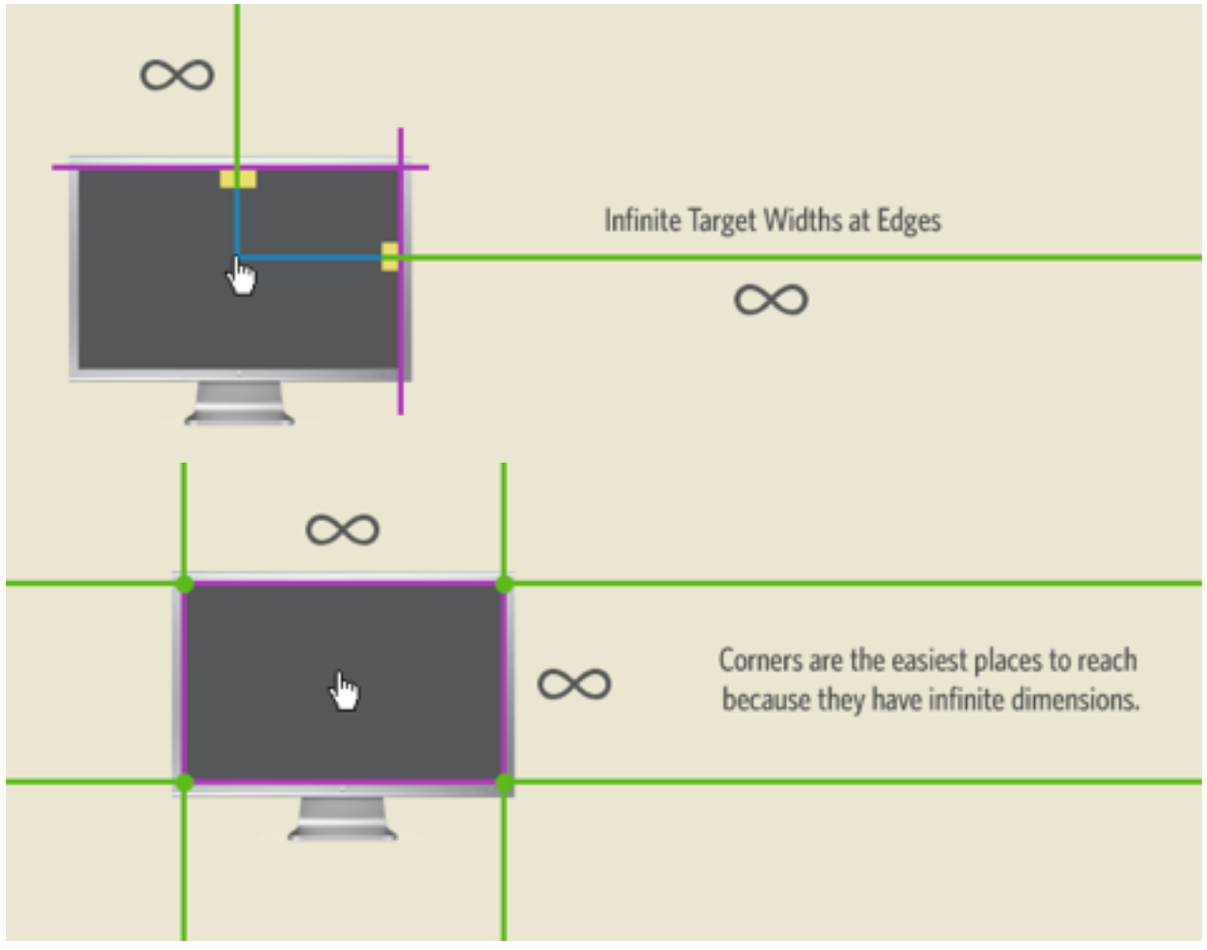
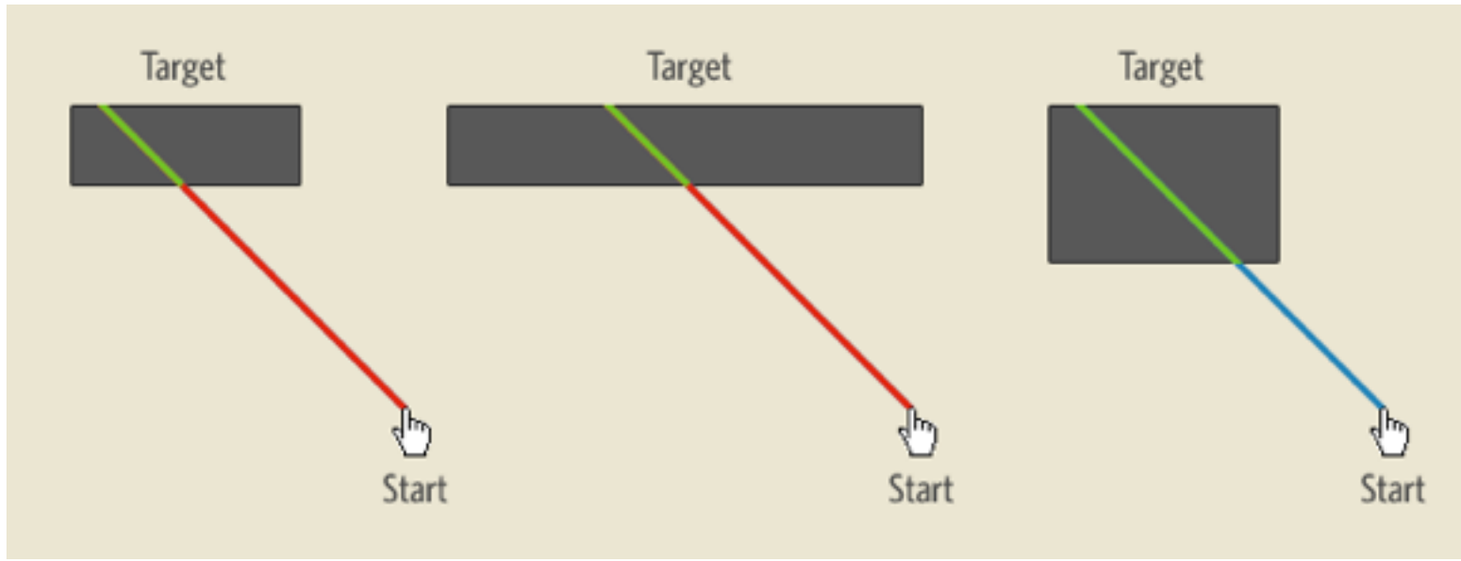


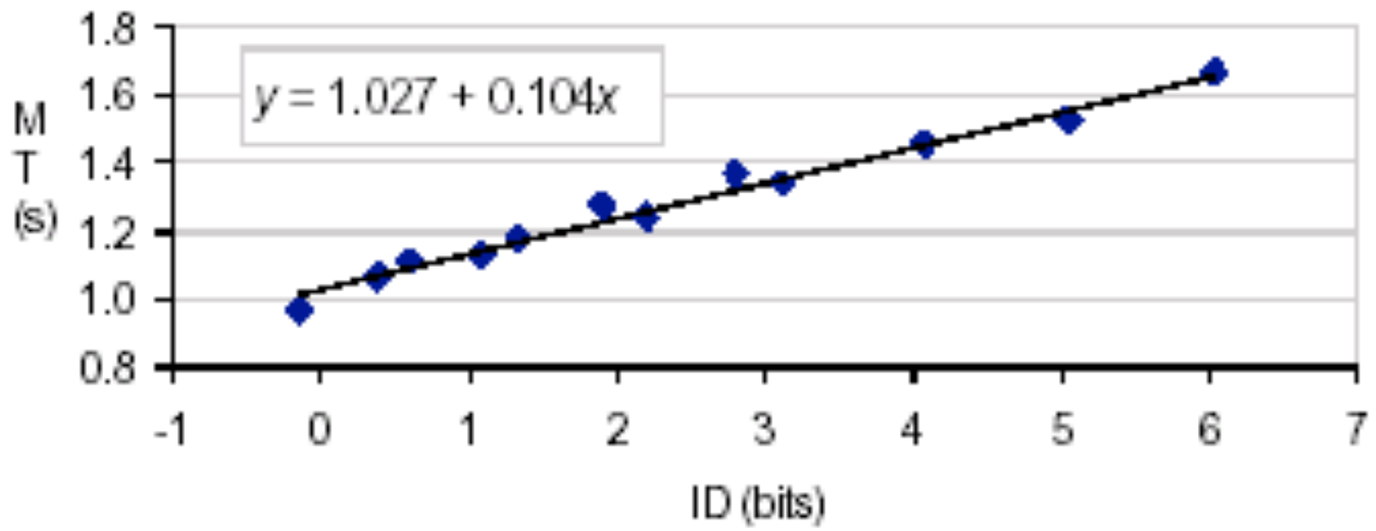
Illustration from http://particletree.com/features/visualizing-fittss-law/

Bigger Is Not Always Better

Movement direction to target



Logarithmic improvements with size



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

Stu Card

A Supporting Science

Interview March 2002

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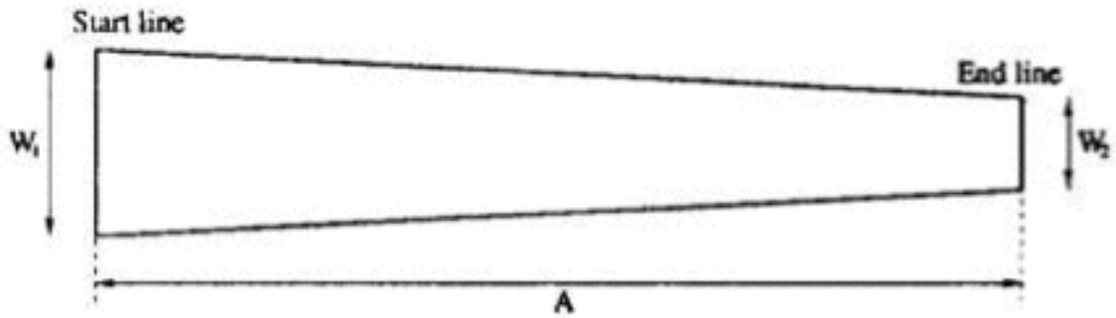
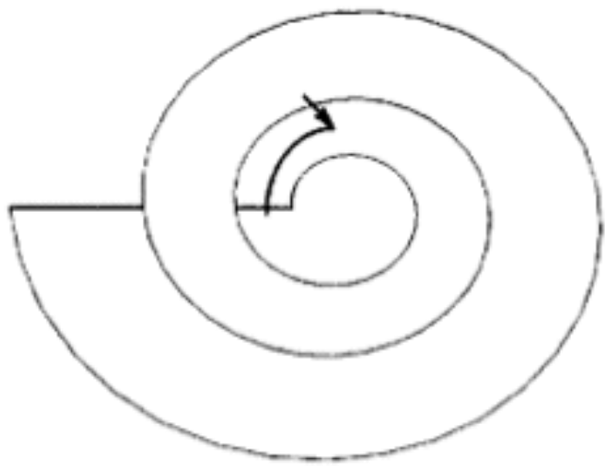
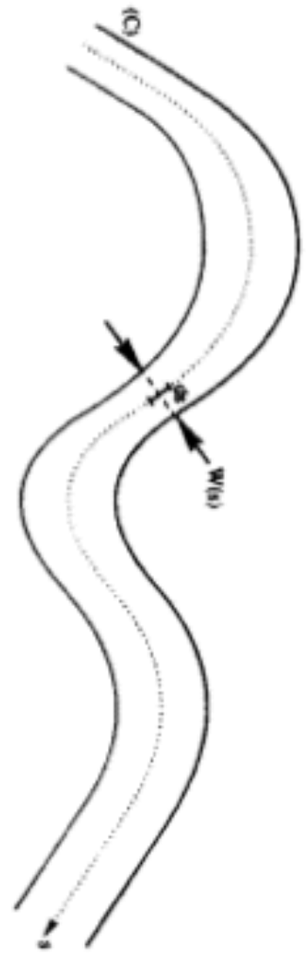
Why is it called Steering Law??

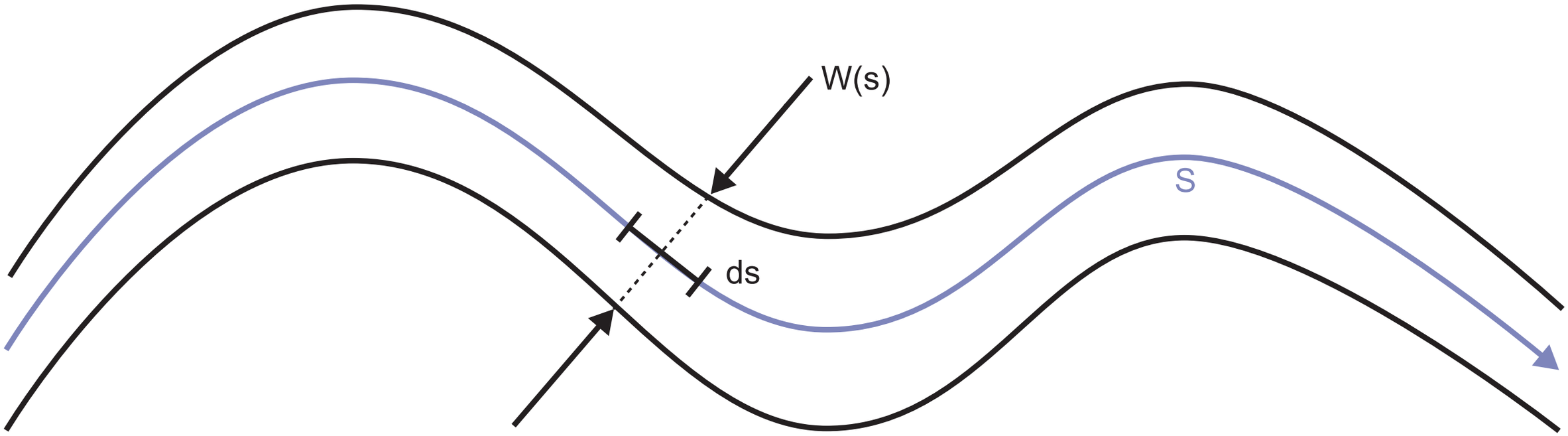
- Early work focused on car driving scenarios and models with straight tunnels
- Various example tunnel shapes have been explored







Steering law on curved paths



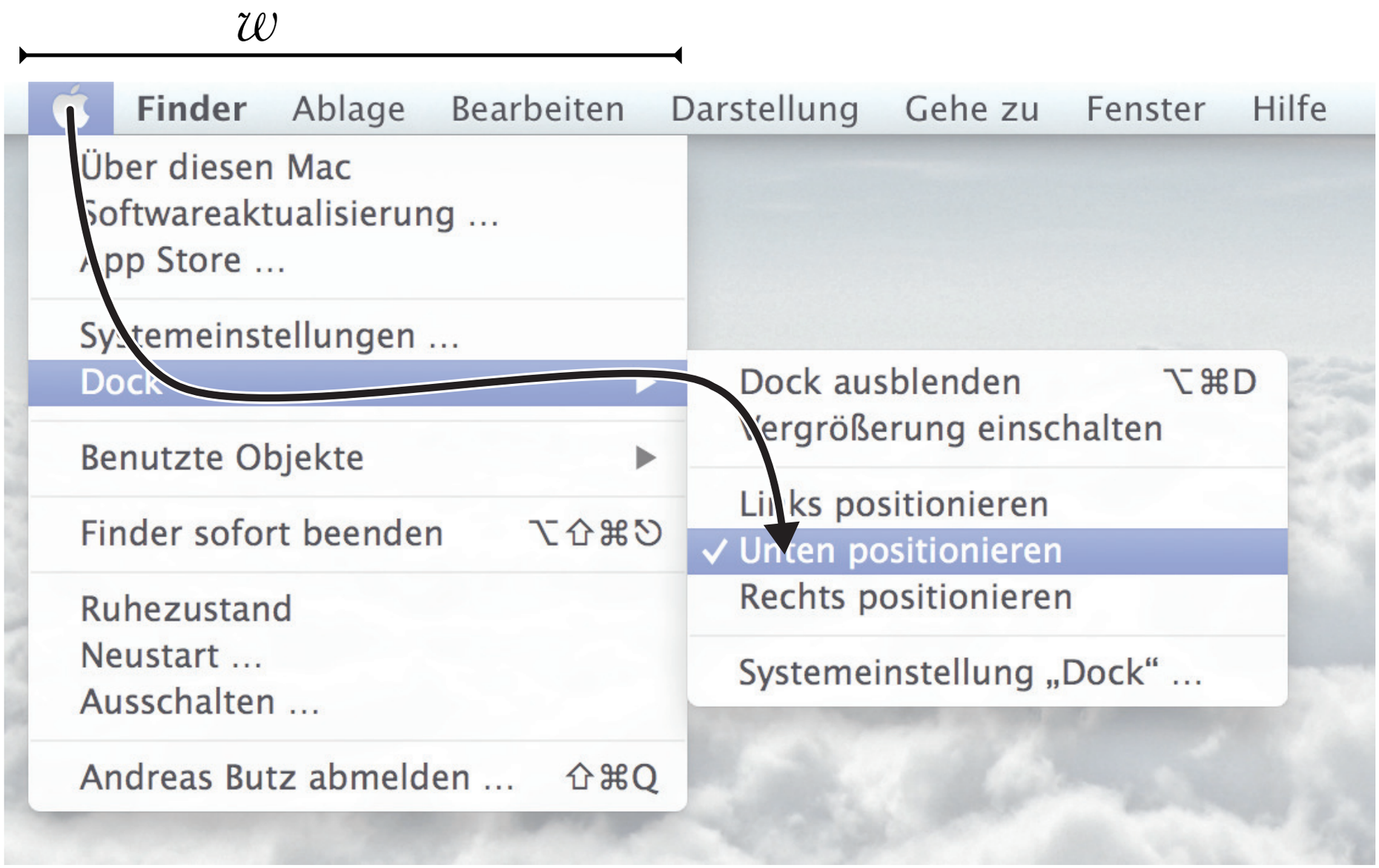
average time to navigate through the path

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

experimentally fitted constants

width of the path at s

Example application of the steering law



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

vertical: Fitts' law horizontal: steering law

Mini-discussion

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

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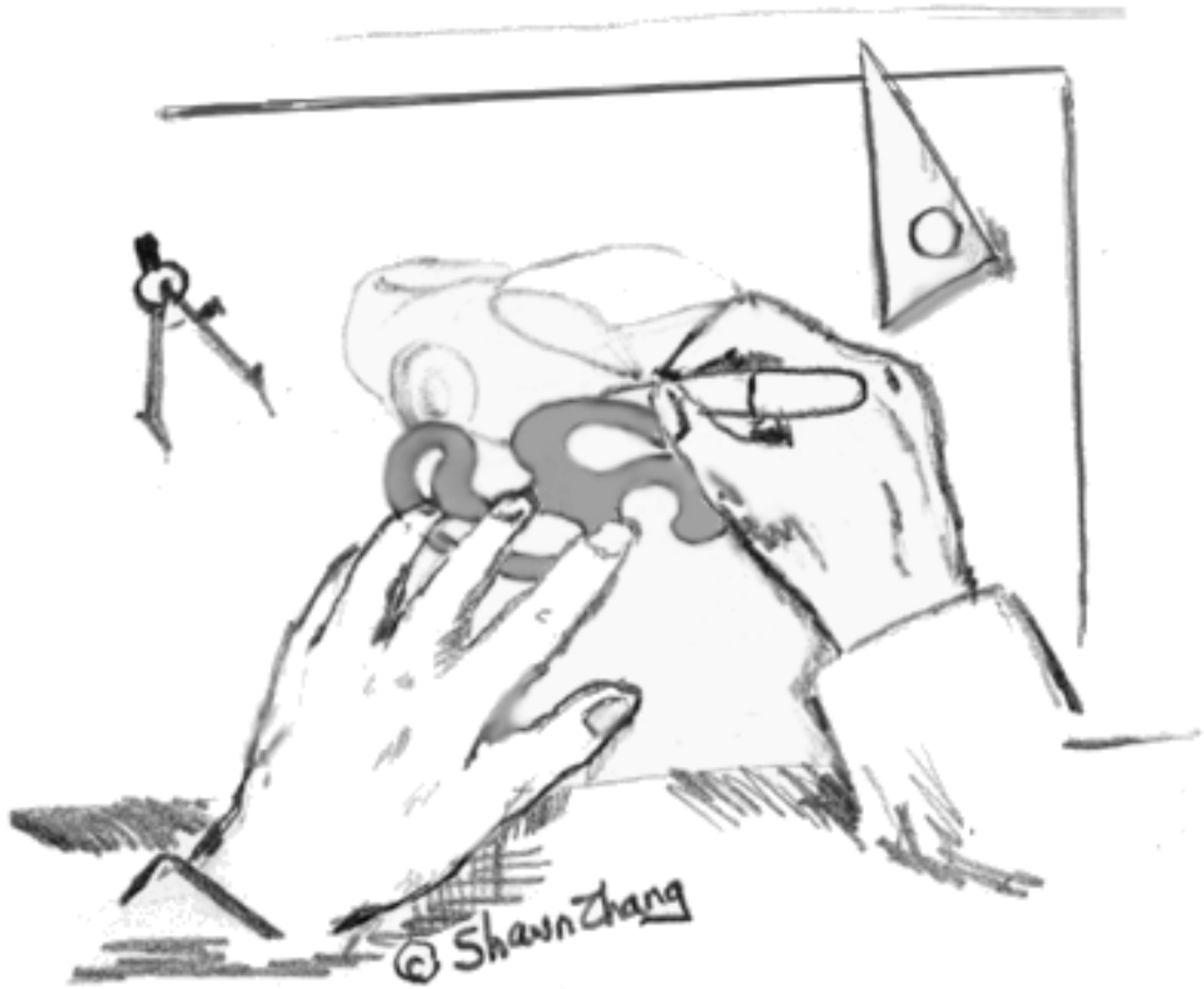
Two-handed motor tasks: a human capability



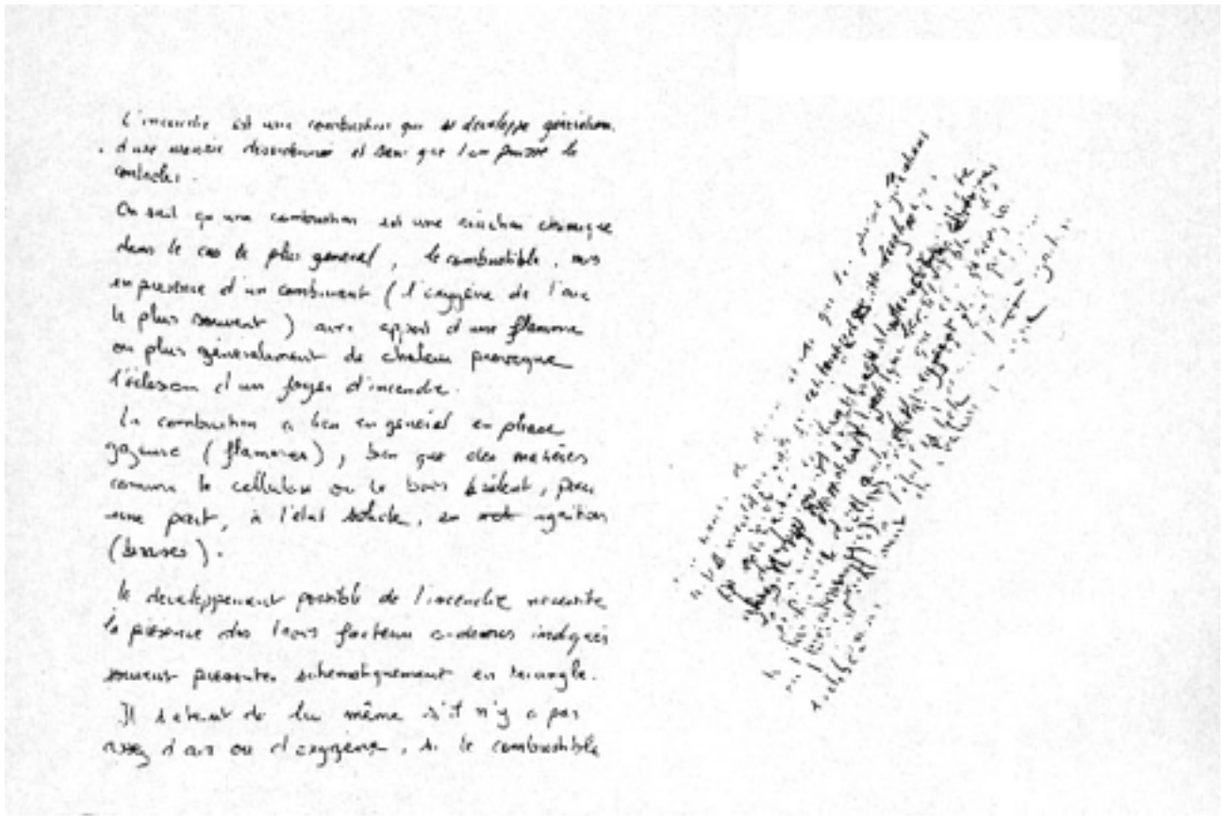
From The Two-Handed Desktop Interface: Are We There Yet? [MacKenzie & Guiard, 2001]

Guiard’s Kinematic Chain

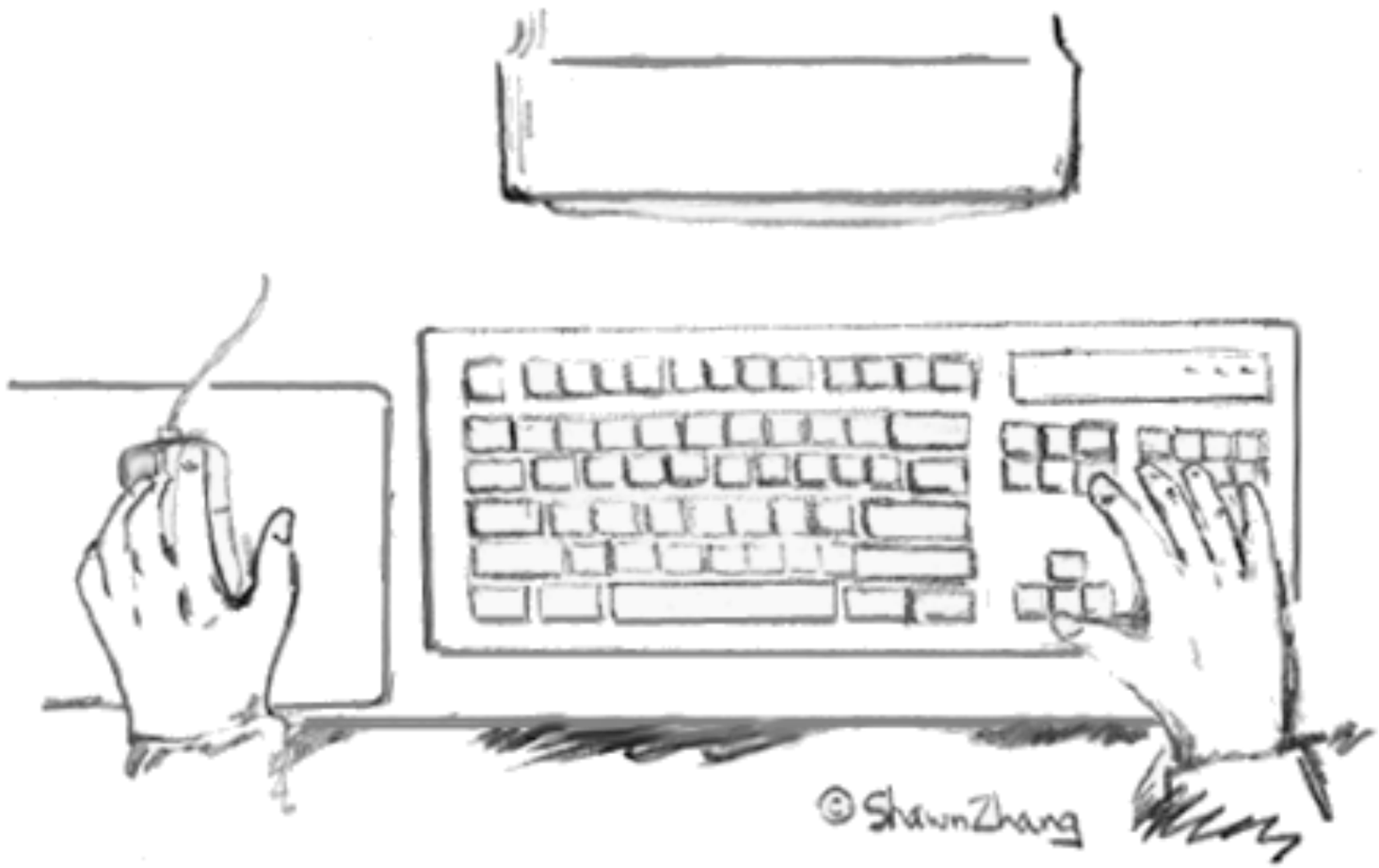
*“Under standard conditions, the spontaneous writing speed of adults is **reduced** by some **20%** when instructions **prevent the non-preferred hand** from manipulating the page”*

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



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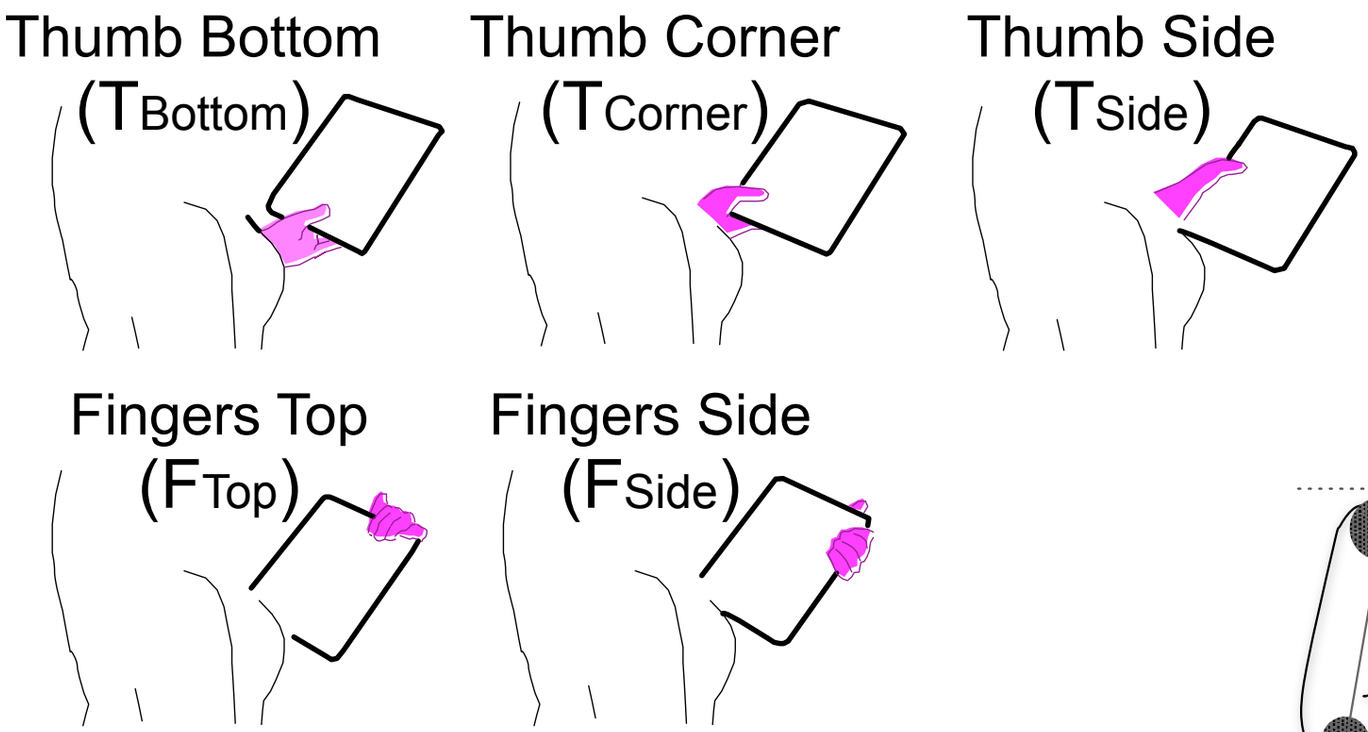
Mini-brainstorming

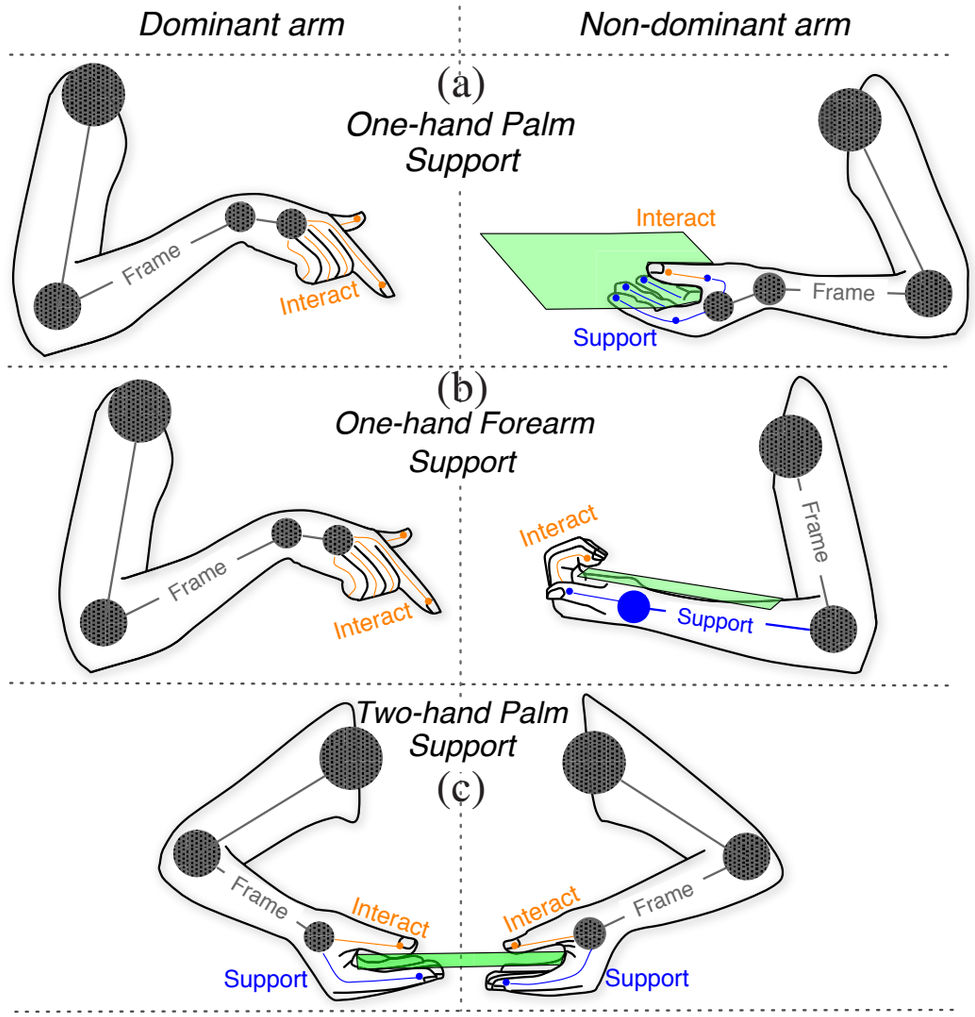
Which tasks in daily life follow a similar distribution of roles between the hands?

Which ones don’t ???

http://www.lobshots.com/wp-content/uploads/2011/08/lobster_560x375.jpg

Application - how do people hold tablets?





J. Wagner, S. Huot, W. E. Mackay. **BiTouch and BiPad: Designing Bimanual Interaction for Hand-held Tablets**. In *CHI'12: Proceedings of the 30th International Conference on Human Factors in Computing Systems*, ACM, May 2012.

Tangible Two-handed Interaction: Example

Hilliges, Otmar, Dominikus Baur und Andreas Butz: Photohelix: Browsing, Sorting and Sharing Digital Photo Collections. In: Proceedings of IEEE Tabletop, pp 87–94. IEEE Computer Society, 2007.

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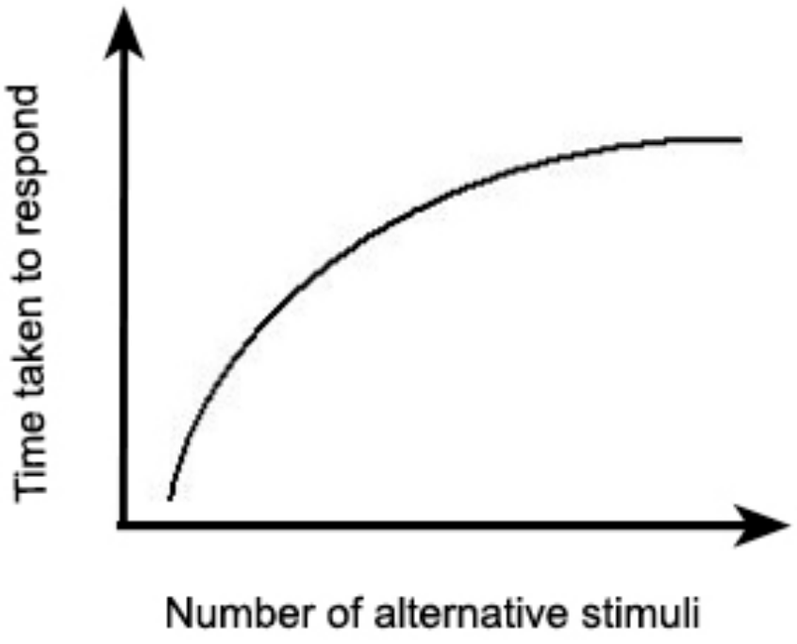
Hick's law

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



binary search strategy

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

Coefficient

Choices

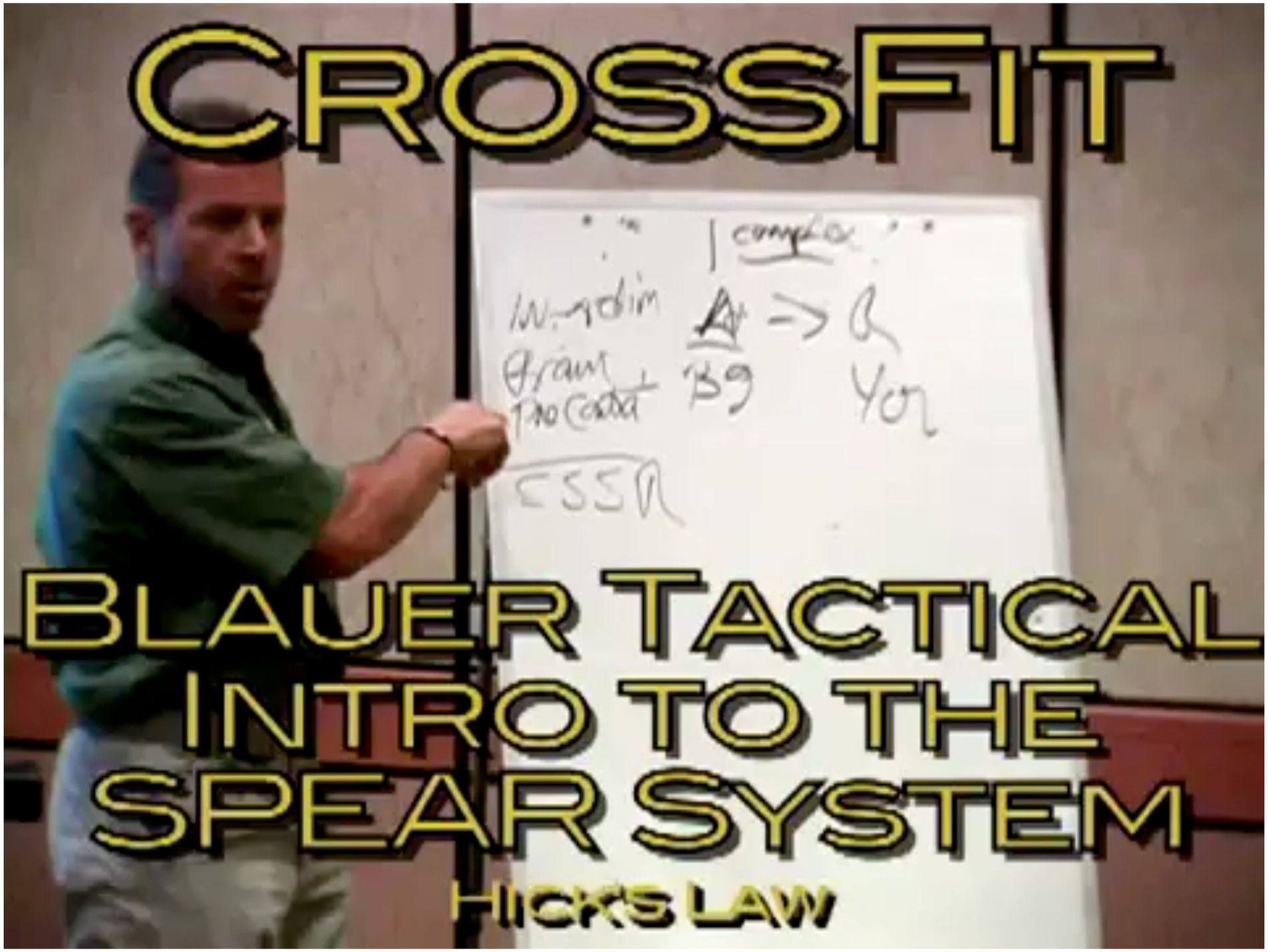
Hick’s Law Examples (really? let’s discuss!)

http://www.hier-luebeck.de/wp-content/uploads/2010/09/StartMenueWindows7.jpg

http://www.photosophic.com/iphone_screen

http://www.youtube.com/watch?v=w0hJveJ8Hp0

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



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

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The Power Law of Practice

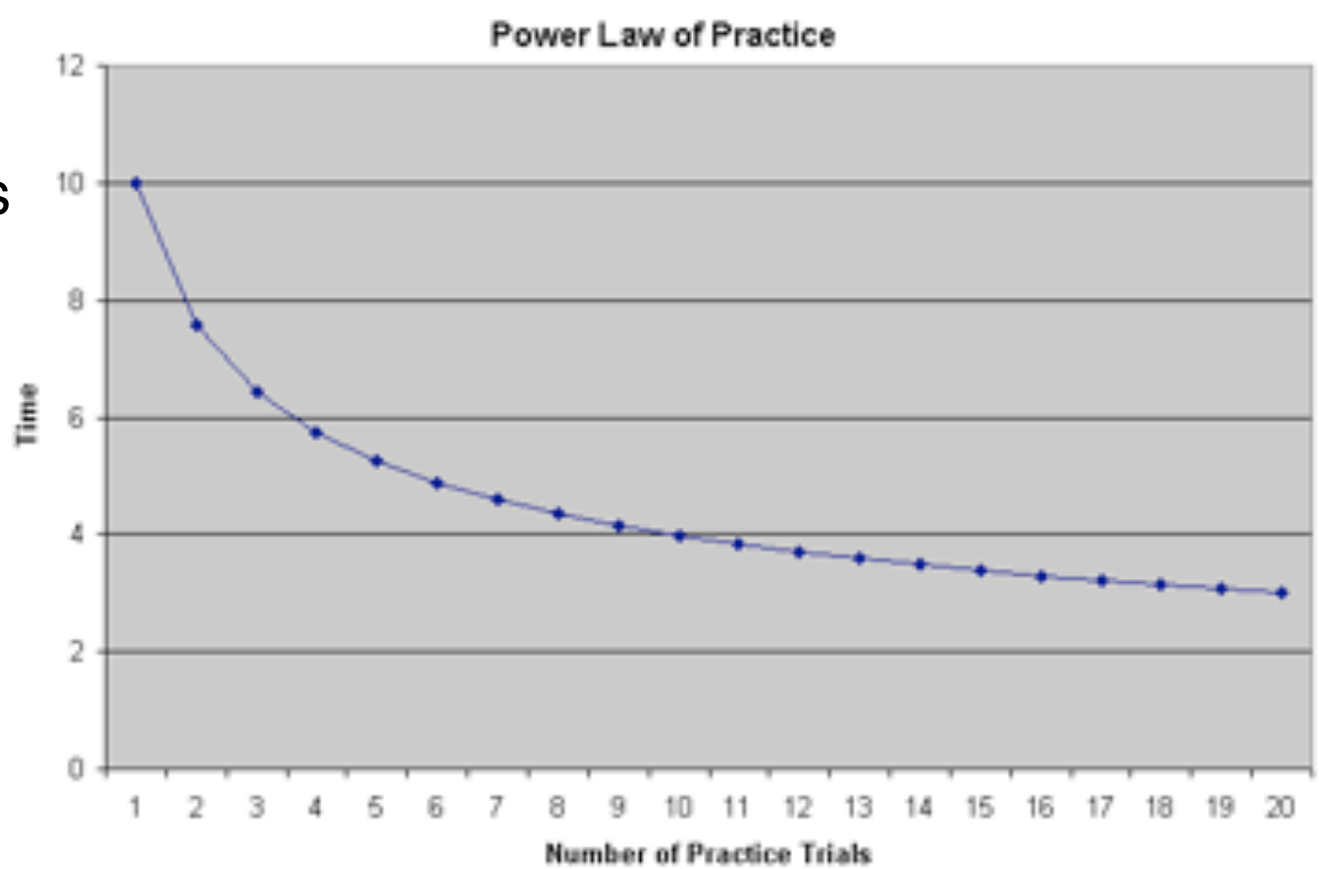
- When performing a task based on practice trials, people improve in speed at a decaying exponential rate.
- The time needed for a particular task decreases in proportion to the number of practice trials taken raised to a power of about a = -0.4
- The logarithm of the time needed for a particular task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

Completion time for trial *n*

Constants

$$T(n) = T(1)\, n^{a} + c$$

Completion time for trial *1*



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Murphy’s law

“Whatever can go wrong, will go wrong.“

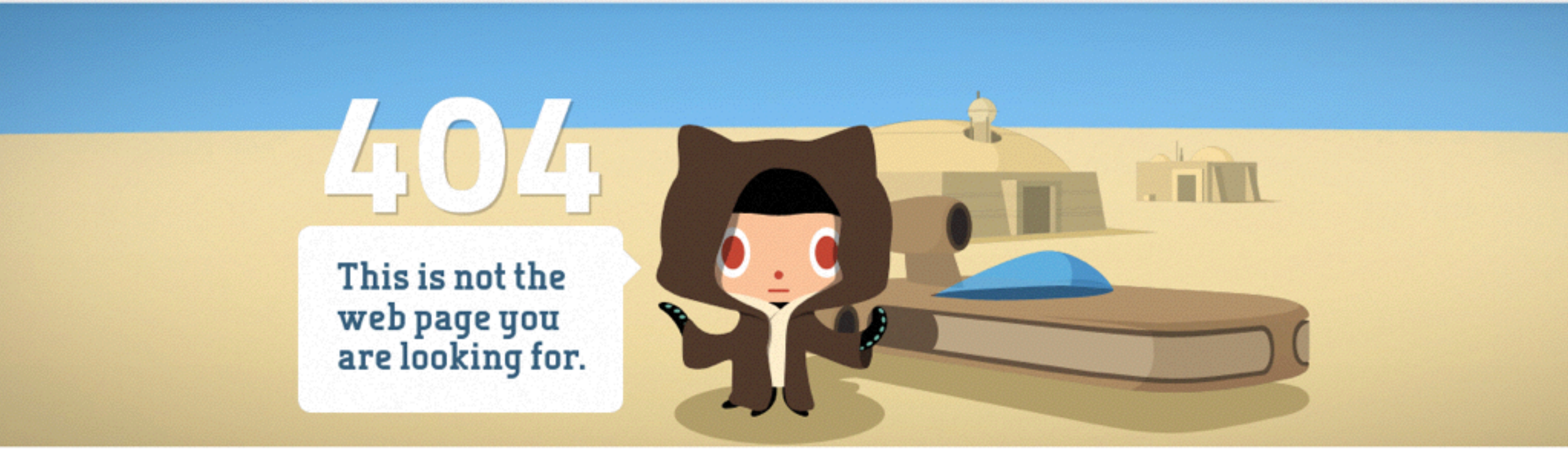
[Edward Aloysius Murphy Jr., 1949]

“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

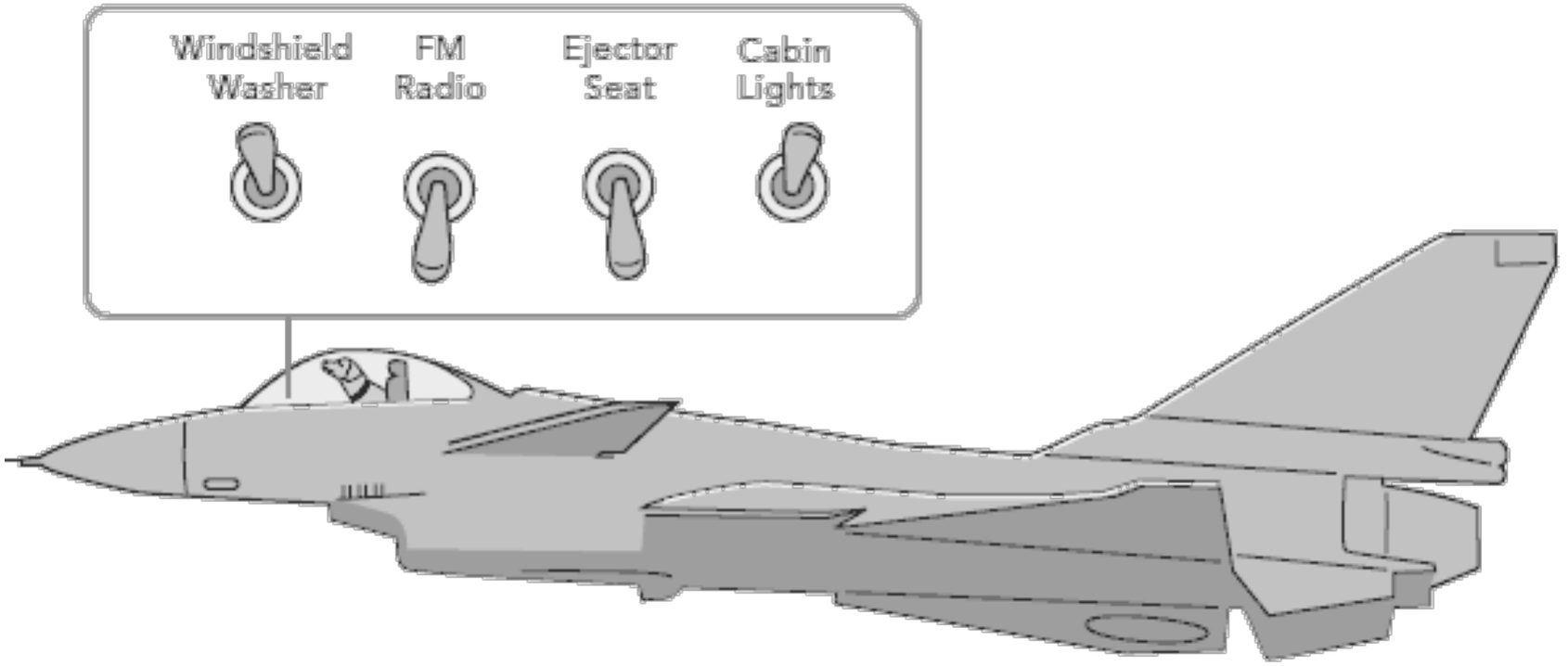
- Prepare for human errors, wrong input etc.
  - do sanity checks in dialogs
  - provide useful defaults
  - make serious mistakes hard

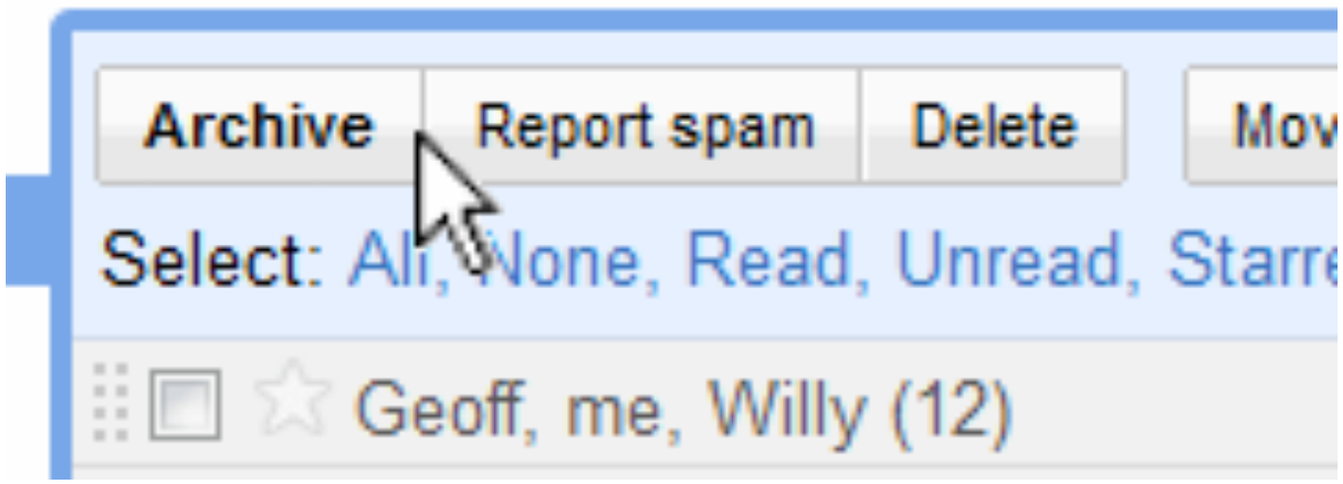
- When building stuff, provide extra time for:
  - mistakes in manufacturing
  - non-functioning tools
  - faulty material
  - misunderstandings



http://www.codinghorror.com/blog/2010/03/the-opposite-of-fitts-law.html

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
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