Interaction Design

Chapter 6 (June 8th, 2011, 9am-12pm): Laws of Interaction Design

Laws of Interaction Design

- Fitts' law
- Hick's law
- Moore's law
- Murphy's law

Fitts‘ law: the original setup

- + 2 other experiments
  in the paper

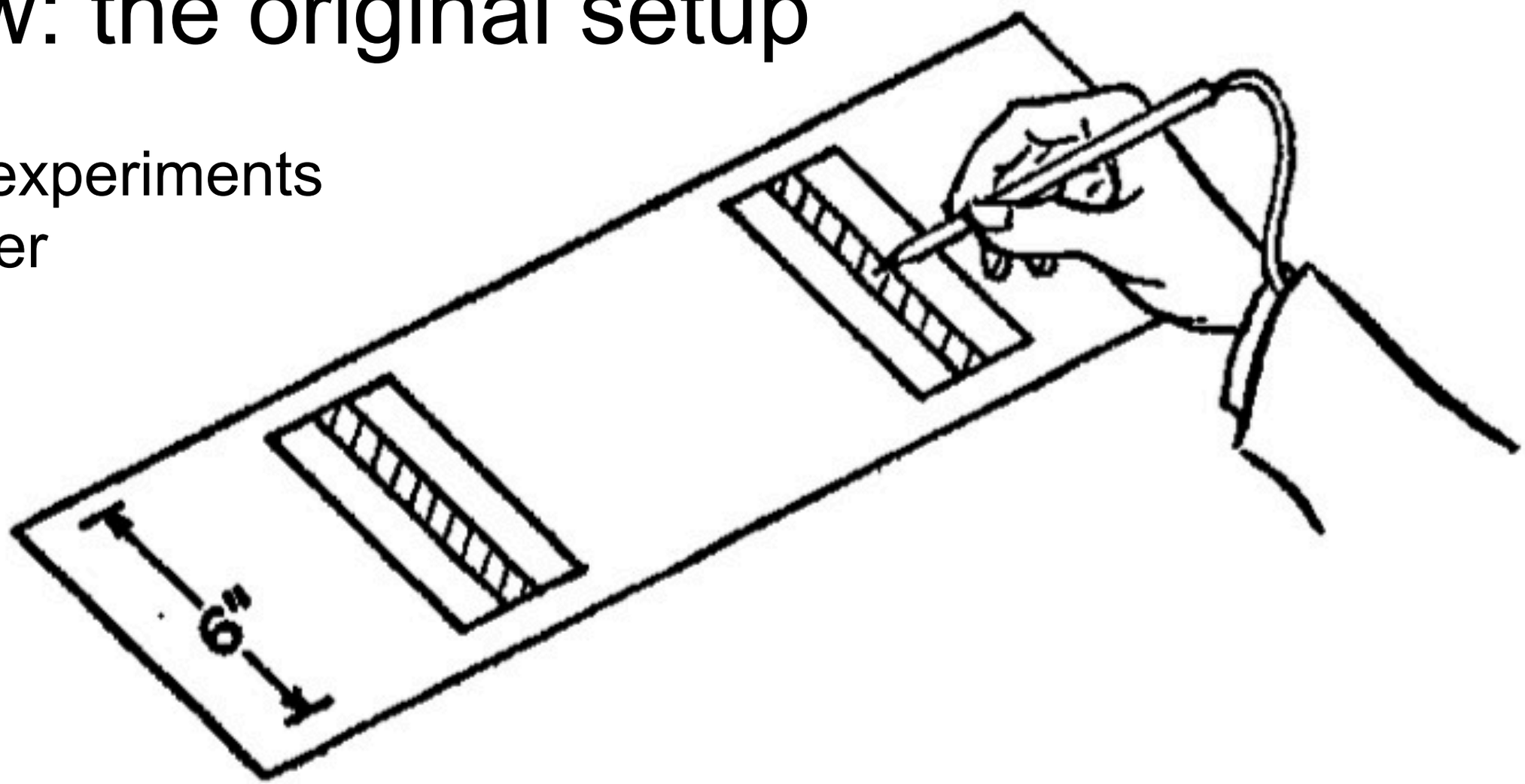


FIG. 1. Reciprocal tapping apparatus. The task was to hit the center plate in each group alternately without touching either side (error) plate.

Fitts, Paul M.: The information capacity of the human motor system in controlling the amplitude of movement. Journal of Experimental Psychology, Vol 47(6), Jun 1954, 381-391. doi: 10.1037/h0055392

TABLE 1

Task Conditions and Performance Data for 16 Variations of a Reciprocal Tapping Task

(N = the same 16 Ss at each condition)

Tolerance and Amplitude Conditions			1-oz. Stylus				1-lb. Stylus			
W_s	A	I_d	t	Errors (%)	I_p	Rank	t	Errors (%)	I_p	Rank
.25	2	4	.392	3.35	10.20	11	.406	3.80	9.85	7
.25	4	5	.484	3.41	10.33	9	.510	3.83	9.80	8
.25	8	6	.580	2.78	10.34	8	.649	4.04	9.24	13
.25	16	7	.731	3.65	9.58	14	.781	4.08	8.96	15
.50	2	3	.281	1.99	10.68	5	.281	0.88	10.68	4
.50	4	4	.372	2.72	10.75	3.5	.370	2.16	10.81	2
.50	8	5	.469	2.05	10.66	6	.485	2.32	10.31	6
.50	16	6	.595	2.73	10.08	12	.641	2.27	9.36	11
1.00	2	2	.212	0.44	9.43	15	.215	0.13	9.30	12
1.00	4	3	.260	1.09	11.54	1	.273	0.85	10.99	1
1.00	8	4	.357	2.38	11.20	2	.373	1.17	10.72	3
1.00	16	5	.481	1.30	10.40	7	.526	1.32	9.50	10
2.00	2	1	.180	0.00	5.56	16	.182	0.00	5.49	16
2.00	4	2	.203	0.08	9.85	13	.219	0.09	9.13	14
2.00	8	3	.279	0.87	10.75	3.5	.284	0.65	10.56	5
2.00	16	4	.388	0.65	10.31	10	.413	1.72	9.68	9

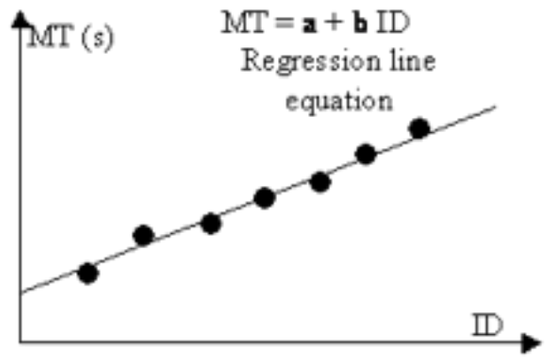
Note.—W_s is the width in inches of the target plate. A is the distance in inches between the centers of the two plates. t is the average time in seconds for a movement from one plate to the other. The performance index, I_p, is discussed in the text.

Fitts‘ law: the formula

$$t = a + b * log_2(\frac{A}{W_t} + 1)$$

- t = time
- a,b = constant values, depending on device
- A = amplitude = distance of movement
- Wt = width of target (along movement axis)

- Here: later formulation by Shannon
- Formula that approximates observed data best
- no significant learning effect
- only slight differences in concentric vs. excentric motions



http://www.interaction-design.org/images/figures/fitts_law_figure_8.gif

Implications of Fitts' law for UI design

$$t = a + b * log_2(\frac{A}{W_t} + 1)$$

http://crossgeared.com/stuff/wp-content/uploads/2007/10/dock.jpg

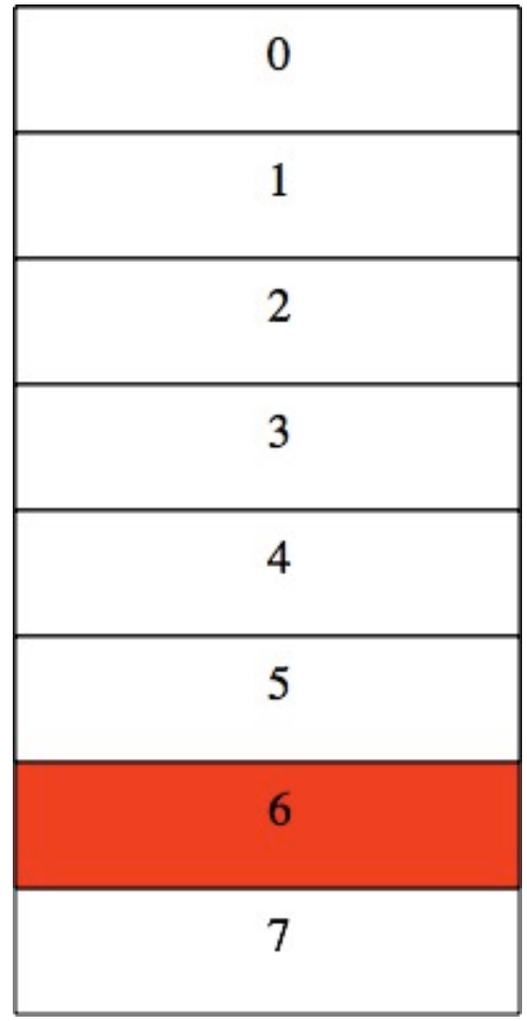
http://fr.wikipedia.org/wiki/Fichier:Emergency_stop_button.jpg

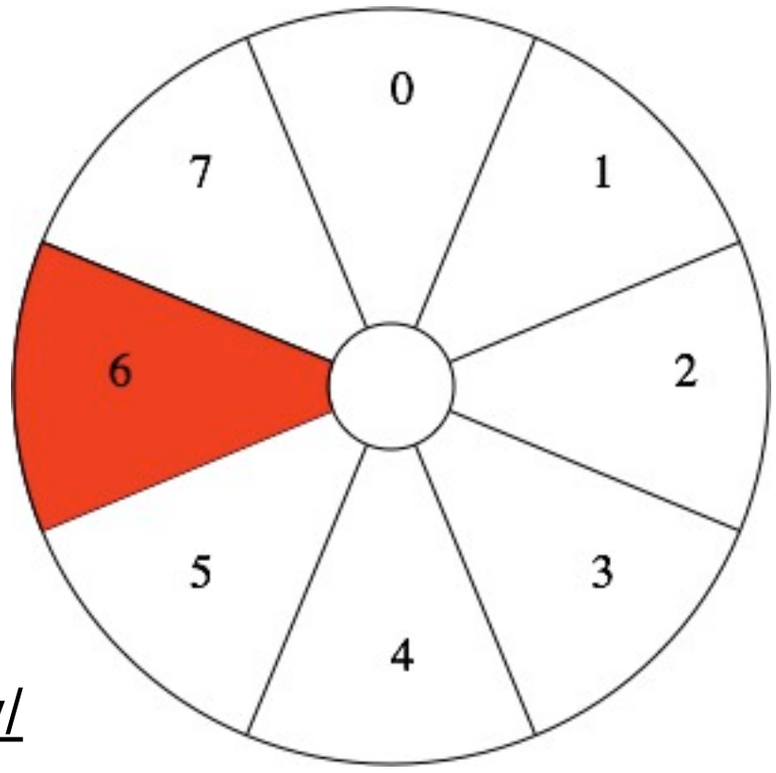
http://www.bergsport-welt.de/product_info.php?products_id=2379

- larger targets are easier to hit
  - –> maximize button size
- movement time increases (logarithmically) with distance
  - –> minimize distances

The case for pie menus

- imagine a pop-up menu with 8 entries
- compare linear menue vs. pie menu
  - selection time for each entry
  - precision/speed tradeoff





- This suggests to only use pie menus!
  - other problems involved
  - http://jonoscript.wordpress.com/2008/10/28/pie-in-the-sky/

Quiz questions [http://www.asktog.com/columns/022DesignedToGiveFitts.html]

- Microsoft Toolbars offer the user the option of displaying a label below each tool. Name at least one reason why labeled tools can be accessed faster. (Assume, for this, that the user knows the tool and does not need the label just simply to identify the tool.)
- You have a palette of tools in a graphics application that consists of a matrix of 16x16-pixel icons laid out as a 2x8 array that lies along the left-hand edge of the screen. Without moving the array from the left-hand side of the screen or changing the size of the icons, what steps can you take to decrease the time necessary to access the average tool?
- A right-handed user is known to be within 10 pixels of the exact center of a large, 1600 X 1200 screen. You will place a single-pixel target on the screen that the user must point to exactly. List the five pixel locations on the screen that the user can access fastest. For extra credit, list them in order from fastest to slowest access.
- Microsoft offers a Taskbar which can be oriented along the top, side or bottom of the screen, enabling users to get to hidden windows and applications. This Taskbar may either be hidden or constantly displayed. Describe at least two reasons why the method of triggering an auto-hidden Microsoft Taskbar is grossly inefficient.
- Explain why a Macintosh pull-down menu can be accessed at least five times faster than a typical Windows pull-down menu. For extra credit, suggest at least two reasons why Microsoft made such an apparently stupid decision.
- What is the bottleneck in hierarchical menus and what techniques could make that bottleneck less of a problem?
- What can you do to linear popup menus to better balance access time for all items?
- The industrial designers let loose on the Mac have screwed up most of the keyboards by cutting their function keys in half so the total depth of the keyboard was reduced by half a key. Why was this incredibly stupid?

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Hick‘s law: the formula

$$t = b * log_2(n + 1)$$

- t = time
- b = constant value, experimentally determined
- n = number of choices

- decision time increases logarithmically with number of choices
  - binary search strategy

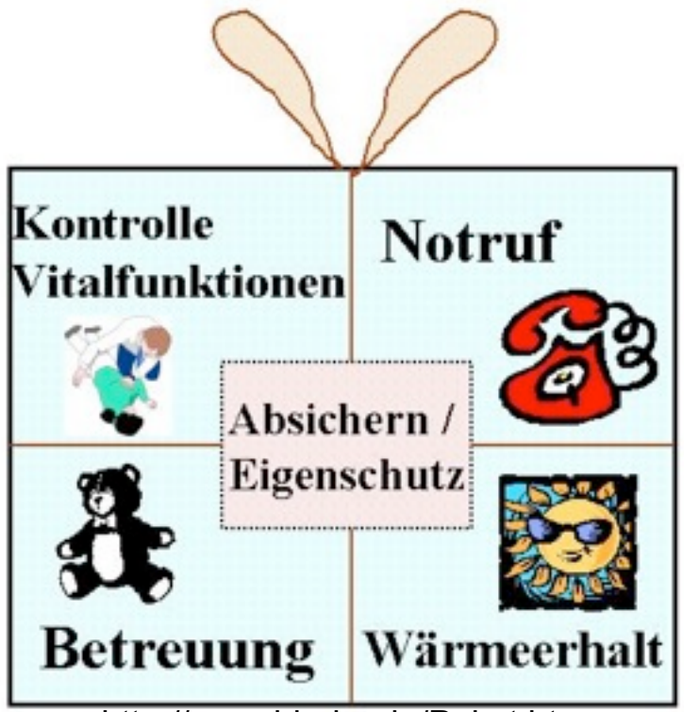
- applies to preattentively percieved stimuli, e.g., lamps lighting up
- does not work for e.g., unordered menu entries
  - have to be read + understood -> linear scanning, even worse!
- works approx. for sorted lists (subdivision strategy)

Hick, William E.; On the rate of gain of information. Quarterly Journal of Experimental Psychology, 4:11-26, 1952

Hick‘s law: examples for discussion

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

http://www.simonblog.com/wordpress/wp-content/uploads/2008/08/dfu_step1.jpg



http://www.j-heim.de/Paket.htm

http://www.neumuenster.de/feuerwehr/files/notruf112.jpg

Hick‘s law in other contexts ;-)

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

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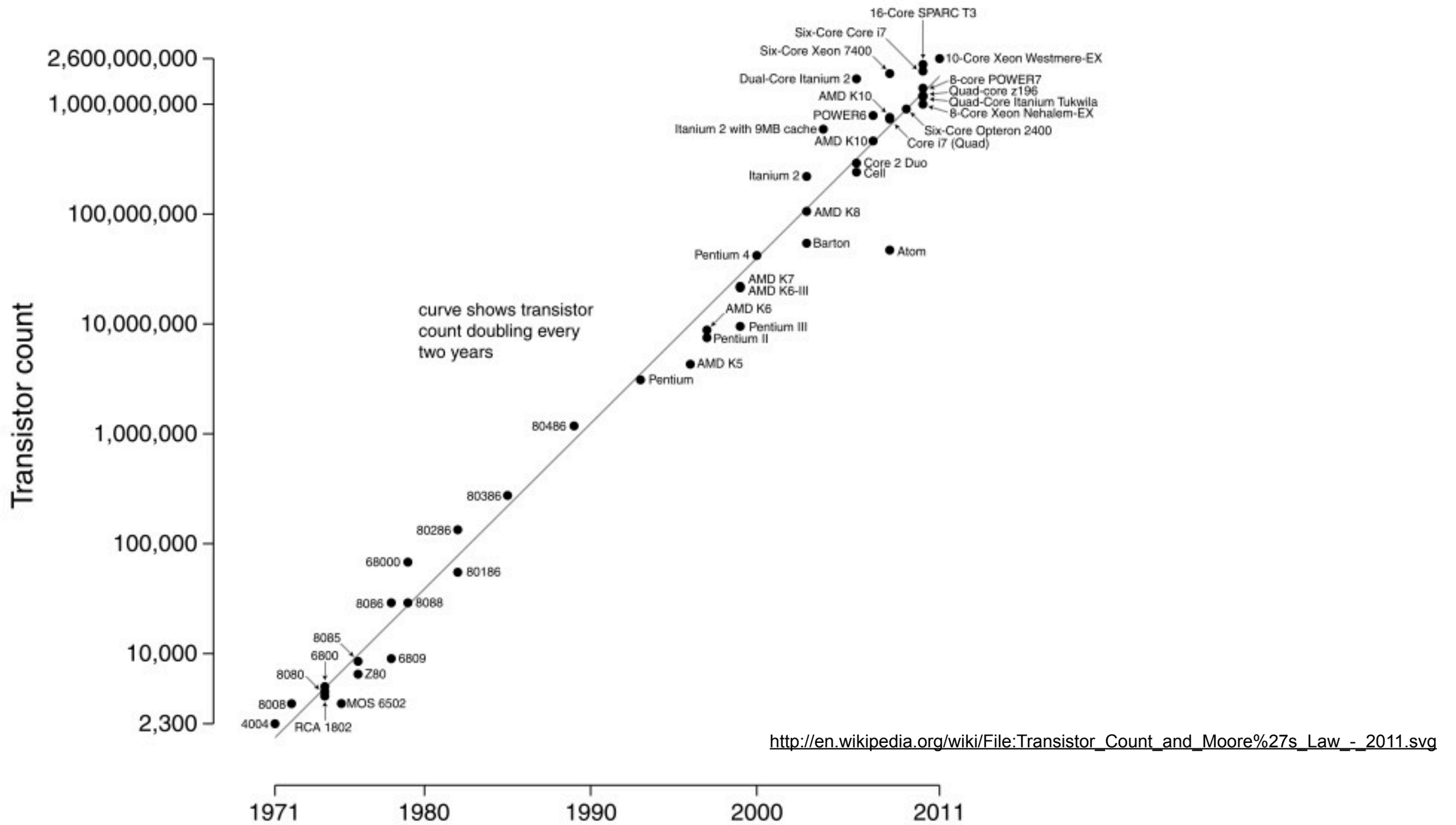
Moore‘s law: the original prediction

- „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. (1965). "Cramming more components onto integrated circuits". Electronics, Volume 38, Number 8, April 19, 1965.]

How well did it predict the last decades?



http://en.wikipedia.org/wiki/File:Transistor_Count_and_Moore%27s_Law_-_2011.svg

Implications of Moore‘s law for IxD

- Don‘t worry too much about...
  - computing power
  - storage capacity
  - screen resolution
  - device size
  - weight
  - battery life (??)

http://en.wikipedia.org/wiki/File:Osborne_Executive_with_iPhone_in_2009.jpg

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Murphy‘s law: the original quote

> „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.“

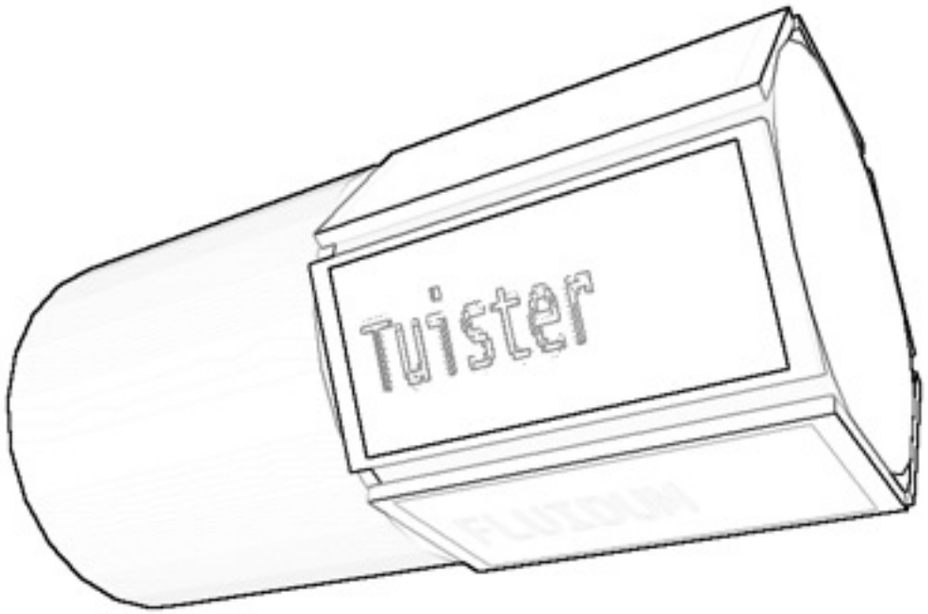
http://www.aufpunkt.de/wp/wp-content/uploads/2011/03/fukushima_01.jpg

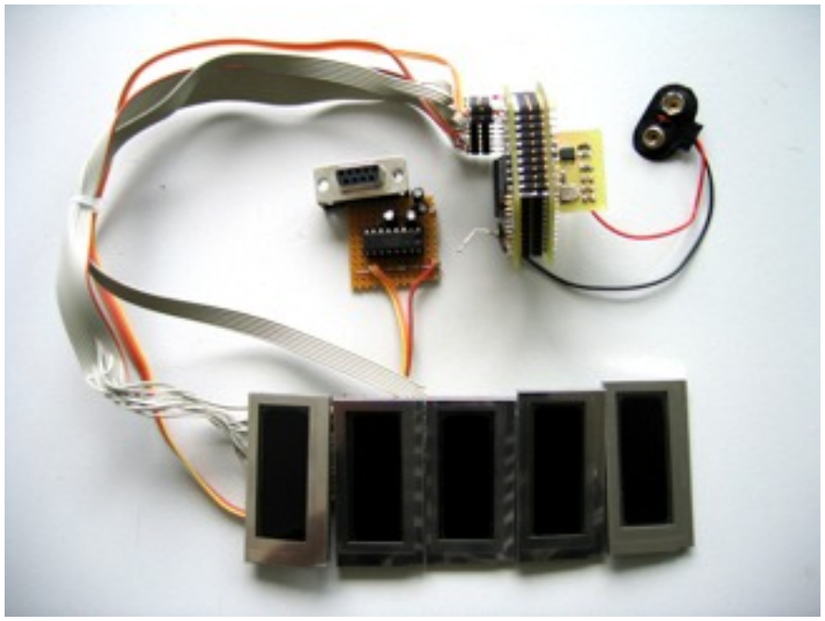
Implications of Murphy‘s law for IxD

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

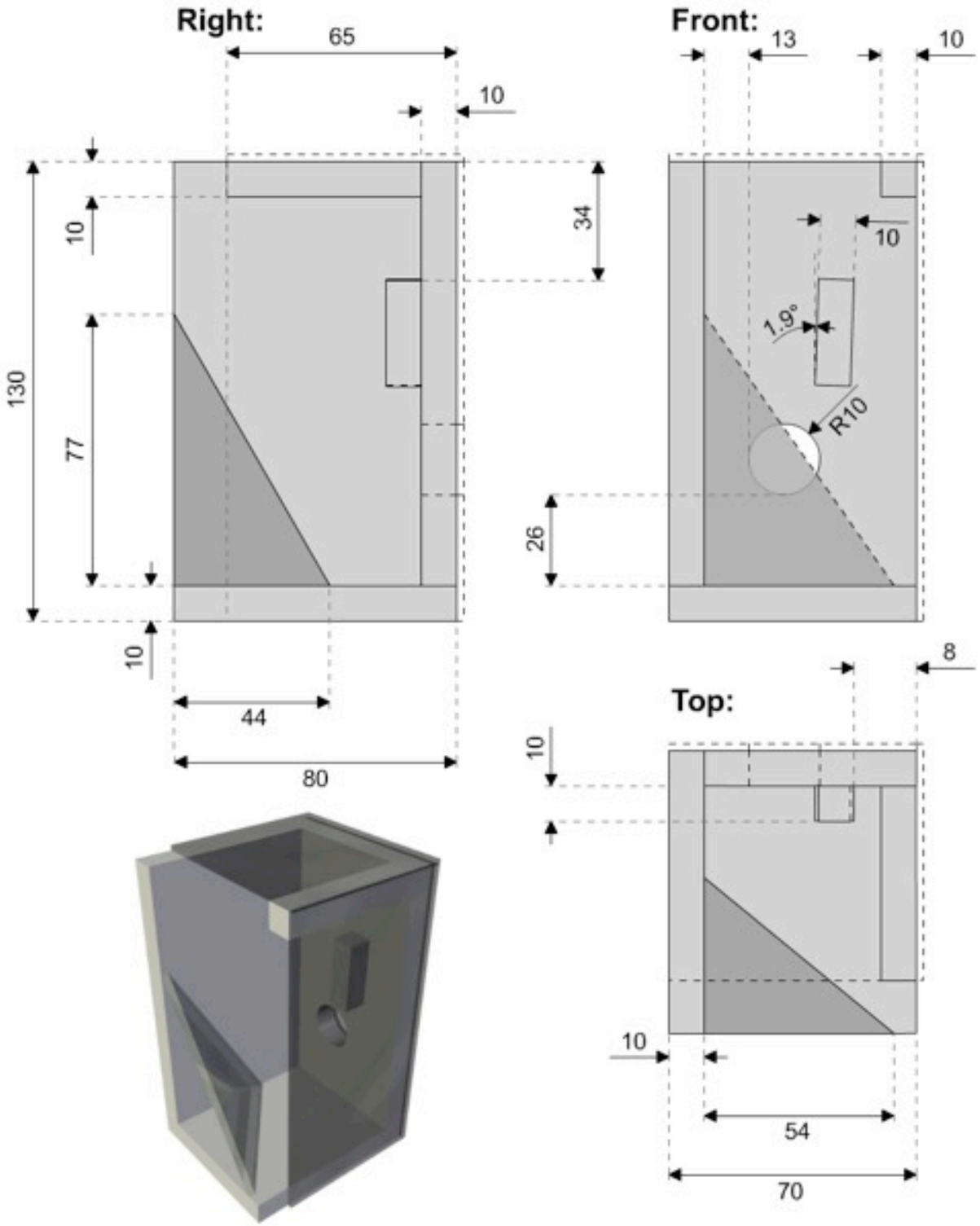
- When building stuff, provide extra time for...
  - mistakes in manufacturing
  - non-functioning tools
  - faulty material
  - misunderstandings

Murphy: example story...





Murphy: more stories



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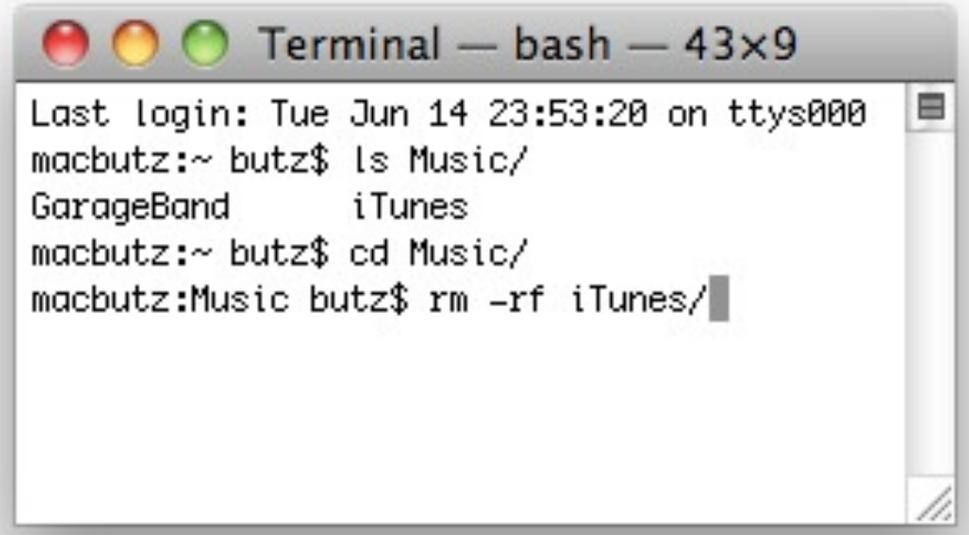
- OAI and AOI Models

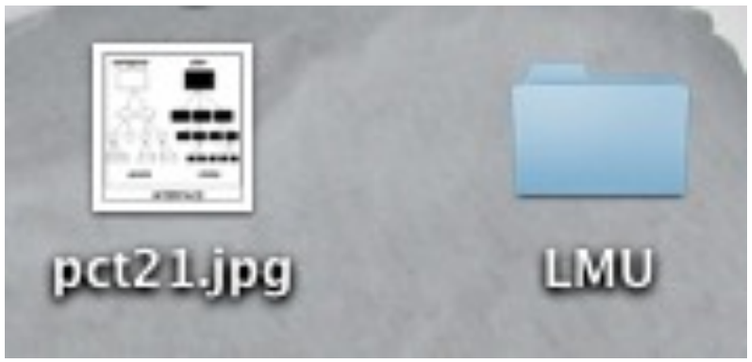
Action - Object Interface Model

- Interaction is a language
  - actions are verbs
  - objects are the nouns



- Action - Object Interface:
  - First choose the action
  - Then choose the object to which it is applied

- Object - Action Interface:
  - First select the object
  - Then select the action to perform



Ben Shneiderman, Catherine Plaisant, Maxine Cohen, Steven Jacobs : Designing the User Interface: Strategies for Effective Human-Computer Interaction, 5/E

AOIM vs. OAIM

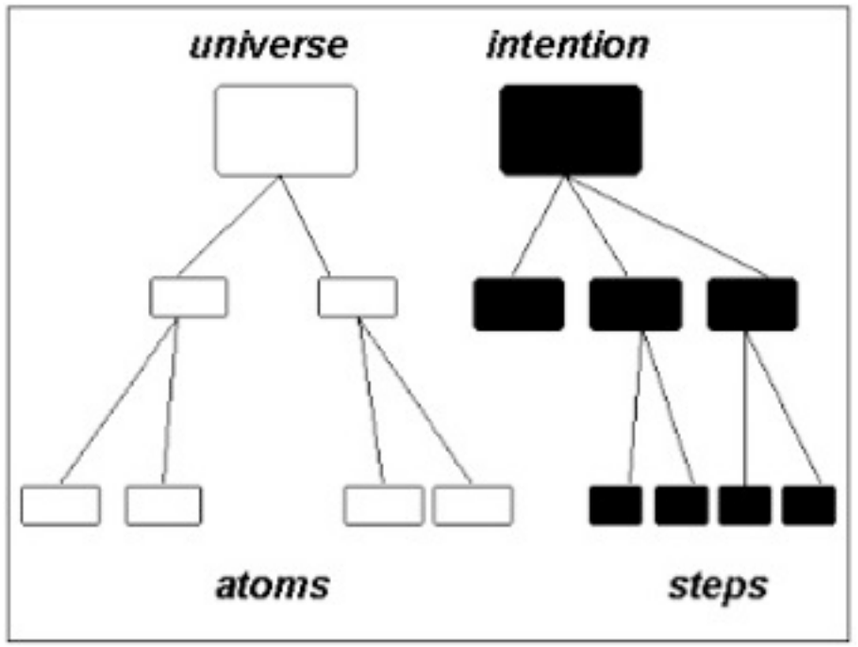
- Which one corresponds closer to the real world?
  - Discussion
  - Tools vs. just objects?

http://www.blogigo.de/jaris_buechergebrabbel/open_book.jpg
http://www.geekalerts.com/u/disc-2gb-pen.jpg
http://3.bp.blogspot.com/_KqBFkCenyyM/TUQ_y7A6BEI/AAAAAAAAACI/YVsPcN1aYmU/s1600/broom+%25281%2529.jpg
http://2.bp.blogspot.com/_kbi0NGanzUM/TGd0OYMTDDI/AAAAAAAAAPk/9i8IjLQpbP0/s1600/fall-leaf-01.jpg

Obj. and action hierarchies

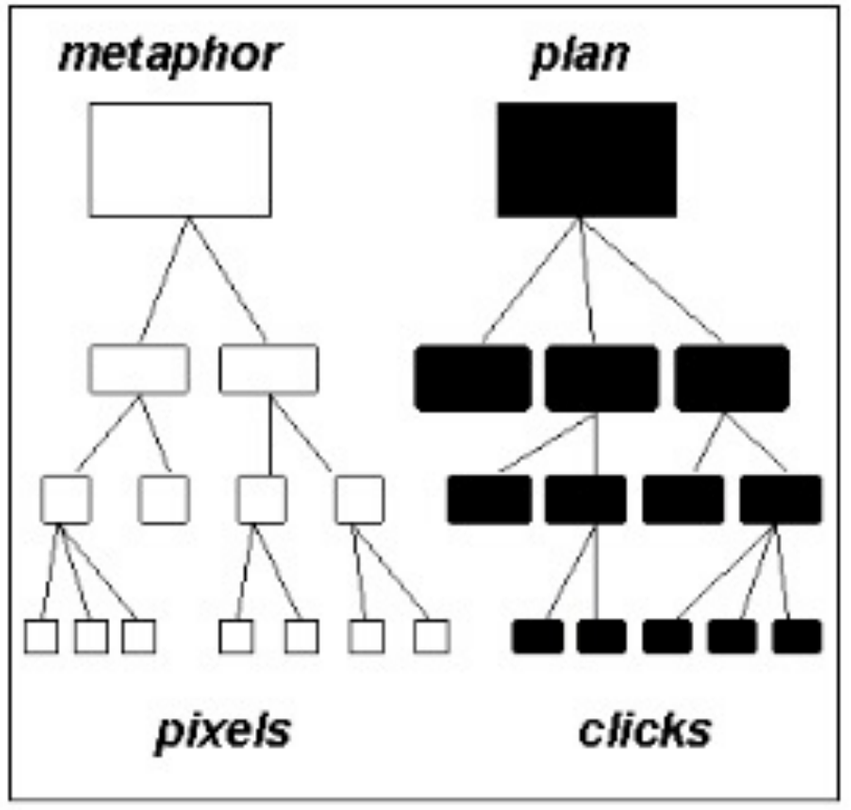
- Objects consist of parts, which consist of ... of atoms
- Intentions eventually lead to a sequence of elementary steps

Figures taken from Ben Shneiderman: DTUI



TASK

- The Interface should represent this hierarchies
  - pixels are the atoms
  - clicks (or touches, movements, gestures?) are the elementary steps



INTERFACE

OAI and AOI summary

- Thinking in objects and actions can provide (a starting point for) an interface structure for the designer
  - find out about the user‘s actions and objects (user research)
  - design visual representations for objects
  - design ways to perform actions
  - clearly distinguish between the two

- When interface objects and actions correspond to real world objects and actions,
  - They are easily understood
  - They are easy to remember
  - Interfaces can be explored by analogy